The Influence of Organic Waste on Vegetable Nutritional Components and Healthy Livelihood, Minna, Niger State, Nigeria

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***Abstract*—**Household waste form a larger proportion of waste generated across the state, accumulation of organic waste is an apparent problem and the existing dump sites could be overstress. Niger state has abundant arable land and water resources thus should be one of the highest producers of agricultural crops in the country. However, the major challenge to agricultural sector today is loss of soil nutrient coupled with high cost of fertilizer. These have continued to increase the use of fertilizer and decomposed solid waste for enhance agricultural yield, which have varying effects on the soil as well a threat to human livelihood. Consequently, vegetable yield samples from poultry droppings, decomposed household waste manure, NPK treatments and control from each replication were subjected to proximate analysis to determine the nutritional and anti-nutritional component as well as heavy metal concentration. Data collected was analyzed using SPSS software and Randomized complete Block Design means were compared. The result shows that the treatments do not devoid the concentrations of any nutritional components while the anti-nutritional analysis proved that NPK had higher oxalate content than control and organic treats. The concentration of lead and cadmium are within safe permissible level while the mercury level exceeded the FAO/WHO maximum permissible limit for the entire treatments depicts the need for urgent intervention to minimize mercury levels in soil and manure in order to mitigate its toxic effect. Thus, eco-agriculture should be widely accepted and promoted by the stakeholders for soil amendment, higher yield, strategies for sustainable environmental protection, food security, poverty eradication, attainment of sustainable development and healthy livelihood.

***Keywords*—**Anti-nutritional, healthy livelihood, nutritional waste, organic waste.

I. Introduction

In Minna urbanization is putting immense pressure on municipal waste management services thus; sustainable management of solid waste has been a major concern of the Niger State Environmental Management Agency (NISEPA). Municipal solid waste management constitutes one of the most crucial health and environmental problem facing African cities [1], [8]. In developing countries the rapid population growth, industrialization, urbanization and growth of economic activities contribute to increasing solid waste (SW) generation [2], [3]. Similarly, [4] indicates that the quantity and generation rate of solid wastes in Nigeria have increased at an alarming rate over the years with lack of efficient and modern technology for the management of the wastes. Generally, Population growth rate in Africa is greater than in other regions of the world, this with attendant urbanization and increase socio-economic activities have aggravated solid waste generation. Most of municipal solid waste comes from residential areas, commercial and other sources [5]. These waste aggregate necessitate the identification of environment-friendly initiatives for effective solid waste management and healthy livelihood at individual and community levels.

The complexity of solid waste generation is a challenge for waste managers particularly in developing countries [6]. Household waste form a larger proportion of waste generated across the state, accumulation of organic waste is an apparent problem and the existing dump sites could be overstress. [1] identified that main component of solid waste is decomposable organic waste which has a range of 42% to 80.2%. Municipal solid waste services are becoming one of the most challenges which if not properly and sustainably dealt with will adversely impact all other development sectors [7]. Moreover, [8] concluded that municipal solid waste management is a serious issue due to its human health and environmental sustainability implications, which has yet to be properly addressed within the FCT Abuja. Solid waste generation and its implication for people and the environment are critical issue for sustainable livelihood. Accurate prediction of waste generation trends facing many fast-growing regions is quite challenging [9]. Hence, it's vital to identify the best approach for dealing with solid waste through sustainable management approach that ensures the good health of the society and the environment as well as the active participation of the society.

Niger state has abundant arable land and water resources thus, should be one of the highest producers of agricultural crops in the country. However, the major challenge to agricultural sector today is loss of soil nutrient coupled with high cost of fertilizer. These have continued to increase the use of chemical products (fertilizer) and decomposed solid waste for enhance agricultural yield, which have varying effects on the soil and is a threat to sustainability of its components and human livelihood. Consequently, there it is crucial to assess the effect of nutrient sources on vegetables

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nutritional and anti-nutritional content for enhance healthy livelihood across the state as soil chemical composition plays important role in the composition of plant materials, according to [10], overall toxic metal availability in soil rhizosphere contributes to metal contents in fruits/ vegetables.

The choice of vegetables for the experiment is mainly because of it crucial role in healthy nutrition and human livelihood. In addition, its cultivation needs to be encourage in Niger State particularly during the dry season for enhance farmers socio-economic livelihood, sustainable agriculture and attainment of food security across the State. Vegetable absorbed high amount of nutrient from the soil an indication for positive result analysis outcome.

II. Methodology

Vegetable yield were collected every five days for twenty five days (5 times) from experimental farm at Pago, Minna Niger State [11]. Yield samples from poultry droppings, decomposed household waste manure, NPK treatment and control were collected from each replication and were subjected to proximate analysis to determine the nutritional and anti-nutritional component. The samples were taken to Biochemistry laboratory Federal University of Technology Minna after collected from the farm for determination of the nutritional and anti-nutritional component. Furthermore, the samples were digested for determination of heavy metal concentration in the various vegetable samples at Ahmadu Bello University (ABU) Zaria. Data collected were analysed using SPSS software and Randomized complete Block Design means were compared. The means followed by the same letter in a row are not significantly different at p=0.05

III. Result and Discussion

A. Proximate Analysis of Nutritional Component

Proximate analysis of the vegetable nutritional component shows that the mean and standard deviation of the sample's nutritional content varies with treatment (Table I). Okra's moisture content analysis indicates that poultry and waste treatment samples had no significant differences in there moisture content and had significantly less moisture content. Similarly, protein content of okra had no significant difference for the three samples while control had significantly high protein content. Furthermore, waste treatment sample had higher fibre content than the other three samples which had no significant difference in their content. There is no significant difference between the ash content of the control, waste and poultry treatment samples but NPK had significantly less ash content. Carbohydrate content varies with varying treatment; though control had significantly less carbohydrate content had significantly less fibre content. Generally, there is no significant difference in the fat and vitamin A content of the four samples. Ash analysis indicates that there is no significant difference in poultry and waste treatment as NPK significantly contains least ash content. Similarly, carbohydrate content analysis of control, poultry dropping and waste treatment sample indicates no significant difference whereas NPK significantly contain least carbohydrate content.

Interestingly, Vitamin A content of poultry dropping and waste treatments are higher and differs significantly with control and NPK. Apparently, NPK treatment sample had the least vitamin A content. Also, there are no significant differences between Vitamin C content of control, poultry dropping and waste while NPK had significantly higher vitamin C content than other samples. Generally, the treatments do not prevent the samples concentration of any of the nutritional components as it's only the amount that varies.

Tomatoes proximate analysis (Table II) indicates no significant differences in the moisture content of the three treatments while control had significantly less water content. Similarly, there is no significant difference between protein content of waste and NPK treatment samples as control had significantly higher protein content. Control sample had significantly higher fibre content; there is significant difference between poultry and waste fibre content while NPK had significantly less fibre content. Generally, there is no significant difference in the fat and vitamin A content of the four samples. Ash analysis indicates that there is no significant difference in poultry and waste treatment as NPK significantly contains least ash content. Also, carbohydrate content analysis of control, poultry dropping and waste treatment sample indicates no significant difference whereas NPK significantly contain least carbohydrate content. Vitamin C proximate analysis reveals no significant differences between poultry and waste treatment samples while NPK contains significantly higher vitamin C content. Fundamentally, the high nutritional content of organic waste reveals the need for its adoption for enhance livelihood.

TABLE I
Okra Nutritional Contents Variance

Nutritional Components	Control	Droppings	Waste	N.P.K
Moisture	88.9250 ± 0.5529^{a}	87.5500 ± 0.4622^{b}	87.2500 ± 0.6008^{b}	88.2750 ± 0.5864^{c}
Proteins	5.4675 ± 0.3691^{a}	5.1250 ± 0.2091^{b}	5.0392 ± 0.1913^{b}	$5.2367 \pm0.3045^{a,b}$
Fibre	3.5975 ± 0.2905^{a}	3.7033 ± 0.3108^{a}	4.1042 ± 0.1541^{b}	3.4900 ± 0.2798^{a}
Fat	0.1183 ± 0.0134^{a}	0.1642 ± 0.0300^{b}	0.1525 ± 0.0280^{b}	0.1475 ± 0.0253^{b}
Ash	0.2025 ± 0.0160^{a}	0.1900 ± 0.0181^{a}	$0.2092\pm0.0211^{a,b}$	0.1800 ± 0.0209^{b}
Carbohydrate	1.6608 ± 0.3735^{a}	3.2400 ± 0.6260^{b}	3.3675 ± 0.7257^{c}	2.5925 ± 0.5228^{c}
Vitamin A	226.2850 ± 37.3931^{a}	350.9825 ± 43.0646^{b}	377.6075 ± 48.6843^{b}	192.8450 ± 70.0424^{a}
Vitamin C	8.1900 ± 0.7901^{a}	8.8933 ± 0.5246^{a}	8.9150 ± 0.6839^{a}	10.3117 ± 0.9028^{b}

The means followed by the same letter in a row are not significantly different at p=0.05

TABLE II
TOMATOES NUTRITIONAL CONTENTS VARIANCE

Nutritional Components	Control	Droppings	Waste	N.P.K
Moisture	87.1633 ± 0.7743[a]	91.2617 ± 0.8671[b]	90.7242 ± 0.7167[b]	91.5717 ± 1.7485[b]
Proteins	5.4283 ±0.6336[a]	2.3492 ±0.1891[b]	3.1325 ±0.2881[c]	2.8083 ±0.2823[c]
Fibre	4.1467±0.1201[a]	3.3450±0.1930[b]	3.2275±0.1812[b]	1.7950±0.2610[c]
Fat	0.1975 ±0.0142[a]	0.3917±0.5891[a]	0.2250±0.0193[a]	0.1992±0.0162[a]
Ash	0.2100±0.0222[a]	0.1708±0.0222[b]	0.1942±0.0363[a,b]	0.1108±0.0257[c]
Carbohydrate	2.7983±0.7410[a]	3.4825±1.8364[a]	2.6358±1.1225[a]	1.3075±0.6365[b]
Vitamin A	273.2683±46.1867[a]	260.8675± 79.8738[a]	244.2950± 76.1443[a]	261.4067± 94.4877[a]
Vitamin C	2.6675±0.2660[a]	2.1275±0.0955[b]	2.2583±0.0827[b]	3.0925±0.0875[c]

The means followed by the same letter in a row are not significantly different at p=0.05

TABLE III
GARDEN EGG NUTRITIONAL CONTENTS VARIANCE

Nutritional Components	Control	Droppings	Waste	N.P.K
Moisture	90.1625 ± 0.4107[a]	91.6150 ± 0.7999[b]	91.3225 ± 1.2891[b]	88.6042 ± 1.1543[c]
Proteins	4.4100 ± 0.2107[a]	3.3450 ± 0.5440[b,c]	3.7908 ± 0.7638[a,c]	4.4875 ±1.1159[a]
Fibre	3.2058 ±0.1613[a,c]	2.5275 ±0.3792[b]	3.1150 ±0.2906[a,c]	3.5283 ±0.2872[a]
Fat	0.3600±0.5737[a]	0.2192±0.0178[a]	0.2142±0.0268[a]	0.2017±0.0212[a]
Ash	0.1650±0.0183[a]	0.1275±0.0365[b]	0.1675±0.0201[a]	0.1825±0.0186[a]
Carbohydrate	1.9050±0.2554[a]	2.1775±0.5319[a,b]	2.1300±0.6796[a]	3.0225±1.3183[b]
Vitamin A	286.1600±104.4793[a]	302.0800±116.2287[a]	266.3133±99.6796[a]	298.5225±128.5362[a]
Vitamin C	1.7700±0.6097[a]	1.8625±0.1941[a]	1.6725±0.1946[a]	2.5600± 0.1792[b]

The means followed by the same letter in a row are not significantly different at p=0.05

Garden Egg proximate analysis (Table III) demonstrate a significant difference in the moisture content of poultry and waste treatment samples as NPK had significantly least moisture content. Protein content analysis shows that there is no significant difference between control and NPK. Also, there is significant difference in fibre and ash content of control, waste and NPK treatments when poultry dropping had least fibre content. Furthermore, there is no significant difference in fat and vitamin A content of the four samples. Similarly, there is no significant difference in the carbohydrate and vitamin C content of control, poultry, and waste treatment samples whereas, NPK significantly contains high carbohydrate and vitamin C content. Fundamentally, the treatments do not devoid the concentration of any nutritional components.

By implication the four samples still contain all the necessary nutritional components but in most cases poultry and waste treatments samples compete very well with control and at times have higher nutritional content specifically, control, poultry and waste often have higher fibre content than NPK treatment. Generally, the entire samples have high moisture content of above 90% to 87%, the results are comparable to the moisture content of 85.6-95.1% reported in fresh water grown leaves, edibles samples [12]. Highest protein content of about 5% is recorded for okra, fat and ash content is generally less than 1%, carbohydrate content ranges from about 1-3% an indication of low carbohydrate content in vegetables. These are comparable with work of [13], and all vegetables showed lower values of ash to those found by [14]. For pumpkin and okra the samples are commonly rich in vitamin content particularly vitamin A. Fundamentally, this indicates that vegetables cultivated using poultry and waste soil treatment contains the entire nutritional requirement for human livelihood.

B. Anti-Nutritional Component Analysis

The anti nutritional component analysis (Table IV) unveils varying level of oxalate concentration in the four samples; Okra depicts no significant difference in oxalate content of the three treatment samples while control contain significantly least oxalate content. Also, there is no significant difference between tomatoes poultry and waste treatment sample's oxalate content when control contains significantly least content and NPK had significant higher oxalate content. Finally, garden egg anti nutritional component analysis shows no significant differences between control, poultry and waste treatment samples as NPK contains significantly higher oxalate content. Consequently, it is proved that NPK had higher oxalate content than control and organic treats. Thus, to help prevent oxalate related diseases, oxalates should be limited to 40 to 50 mg per day [15]. Our findings presented the highest level of 8.3308 mg/100ml, so we are not likely to consume above 40 to 50 mg per day from vegetable alone thereby placing us on a safer side with respect to oxalate.

TABLE IV
ANTINUTRITIONAL COMPONENTS VARIANCE

Vegetable	Control	Droppings	Waste	N.P.K
Okra	5.6500±0.3098[a]	8.2092±0.0602[b]	8.1475±0.0741[b]	8.1450±0.1377[b]
Tomatoes	6.7350±0.2594[a]	7.2817±0.1849[b]	7.2525±0.0682[b]	7.5675±0.0974[c]
Garden Egg	7.4250±0.2386[a]	7.3692±0.1914[a]	7.3875±0.2200[a]	8.3308±0.2424[b]

The means followed by the same letter in a row are not significantly different at p=0.05

`Oxalate is the main anti nutritional compound determined and it is naturally occurring compound found in almost all plants, animals and humans [16]. Oxalate is among the most commonly found anti-nutrient in vegetables especially the green leafy ones. As anti-nutrients, oxalic acid potentially binds to dietary magnesium and calcium to form insoluble Ca or Mg oxalate, which leads to low serum Mg or Ca levels and further to renal failure due to precipitation of these salts in the kidney a condition known as kidney stone [17]. The small amount of Oxalate compound found in the four samples is typical of all vegetables however the lower oxalate content in control and organic treatment samples signify that no treatment and organic treatment are still better for human livelihood than chemical treatment. Consequently, the present research proves that organic treatment is exclusively the best amendment for soil; its records the best vegetable performance (height and leave concentration), highest yield record, had all the required nutritional content and less oxalate concentration when compare to other treatment like NPK. The finding of [18] has shown that blanching for only about ten minute can reduce oxalate level to a bearable minimal concentration which is considered safe.

C. Vegetable Uptake of Heavy Metals Analysis

The initial nutrient concentrations shown that the organic carbon/total nitrogen, P, Na+, K+ and Ca+ compositions of the poultry droppings and decompose waste were higher than that of the soil (control) except for Mg+, and CaCl2 that were higher in the control than decompose waste. Hence, when applied to the soil, they can either act antagonistically or synergistically or rarely have no effect on the levels of heavy metals present in that soil and that will eventually be taken up by the vegetables.

In the tomato plant treatments (Table V), the mercury levels were significantly higher than cadmium and lead levels for all the treatments. Across the treatments, the mercury levels in the vegetable from the waste treatment was significantly higher at a mean value of 3.129 ppm when compared to the control (2.504 ppm), poultry droppings (1.829 ppm) and NPK (1.537 ppm) levels. The control treated tomatoes having this level of mercury (2.504ppm) clearly indicate that the soil has been contaminated before the experiment. Also higher level of mercury in the waste treated tomatoes is an indicative of the presence of mercurial waste which added to the soil has synergistically increased the level of mercury taken up by the plant. No cadmium was found between the treatments inferring that the soil and the other forms of treatment have level of cadmium below detection.

Mean lead level of 0.023ppm was obtained in the control tomato alone. Its absence in the other treatments indicates an antagonistic reaction probably due to metal chelating that has made the lead unavailable. Meanwhile sampling done in Borno state by [19] reported 0.1332ppm of both lead and cadmium in tomato samples.

The garden egg vegetable followed a similar trend of higher level of mercury (1.606-6.791ppm) thnn cadmium (0.000-0.001ppm) and lead (0.046-0.056ppm) for all treatments (Table VI). The deviation from the trend in tomato treatments is in the presence of 0.001ppm of cadmium in the plant treated with waste and the presence of 0.046ppm and 0.056ppm of lead for waste and NPK treated garden egg respectively. Reference [19] reported 0.1401ppm of Cadmium in unwashed garden egg and 0.1261ppm when it was washed it added that Cadmium accumulates in many agricultural crops mainly as a result of the use of sewage sludge or phosphate fertilizers.

TABLE V
MERCURY, CADMIUM AND LEAD CONCENTRATION VARIANCE IN TOMATO

Treatments	Mercury	Cadmium	Lead
Control	2.504 ±0.0002[a]	0.000 ± 0.0001[a]	0.023 ± 0.0005[a]
Waste	3.129 ±0.0001[b]	0.000 ± 0.0001[a]	0.000 ± 0.0003[b]
Poultry Dropping	1.829 ± 0.0001[c]	0.000 ± 0.0001[a]	0.000 ± 0.0001[b]
NPK	1.537 ± 0.0002[d]	0.000 ± 0.0001[a]	0.000 ± 0.0003[b]

The means followed by the same letter in a row are not significantly different at p=0.05

In addition, [20] report low cadmium concentration of 0.014mg/g in the leaves of *Corchorus olitorius* and [21] reports mean *Vernonia amygdlina* Cd concentration of 0.0006mg/g. This low cadmium trend is similar to that in our finding. Occurrence data for the three EU member countries; France, Germany and UK reported in [22] indicated mercury levels ranging from 0.0006-1.17 µg/g. In comparison, our findings present higher values normalizing the units. SCOOP also reported lead levels in vegetable from eleven EU member states between 0.004 and 0.6 µg/g, this is similar to our findings thereby confirming that lead and cadmium concentration in the entire treatment is safe for consumption and healthy livelihood, when compare with EU member of states values.

TABLE VI
MERCURY, CADMIUM AND LEAD CONCENTRATION VARIANCE IN GARDEN EGG

Treatments	Mercury	Cadmium	Lead
Control	3.894 ±0.0005[a]	0.000 ± 0.0006[a]	0.000 ± 0.0002[a]
Waste	6.791 ± 0.0020[b]	0.001 ± 0.0002[b]	0.054 ± 0.0002[b]
Poultry Dropping	1.764 ± 0.0002[c]	0.000 ±0.0003[a]	0.000 ± 0.0002[a]
NPK	1.606 ± 0.0002[c]	0.000 ± 0.0006[a]	0.046 ± 0.0004[c]

The means followed by the same letter in a row are not significantly different at p=0.05

In the case of this study, if we are to adopt the FAO/WHO dietary goal recommendation on the consumption of 400g/day (2800 mg/week) vegetable, per week, we will then be consuming; 8.9572 mg/week, 13.888 mg/week, 5.0316 mg/week and 4.4016 mg/week of mercury content from control, waste, poultry droppings, and NPK treated vegetables respectively. These figures are alarming and require urgent intervention with respect to mercury levels in soil and manure in order to mitigate its toxic effect. A number of serious health challenges including depletion of essential body nutrients which contributes to diseases can develop as a result of excessive uptake of heavy metals [23].

The findings in our study have shown that Cd and Pb levels in the vegetables were within safe limits based on the [24], [25] cadmium maximum levels of 0.05 ppm for fruiting vegetable applicable to okra, tomato and garden egg. However, the exceeded EU PTWI of 0.025 mg/kg bodyweight for lead from all vegetable treatments except poultry dropping is indication of possible build up effect. In addition, Mercury which has Central Nervous System (CNS) and kidney damaging potential [26], was found at alarming levels all through the samples when compared to the FAO/WHO [24], [25] maximum levels of 0.03ppm for food and food products [27]. Taking the mean for mercury levels of both garden egg and tomato, we arrive at mean values of 3.199 ppm, 4.960 ppm, 1.797 ppm and 1.572 ppm for control, waste, poultry droppings and NPK treated vegetables respectively.

By this result, decomposed waste treatment has the highest concentration of Hg, followed by control while NPK has the least Hg content but not withstanding all the values are above permissible level. Moreover, this indicates that high mercury content is not limited to any type of treatment adopted as even control still record high mercury concentration. Consequently, there is need to identify ways of minimizing mercury concentration from the soil and all type of manure treatment to enhance soil fertility. Adoption of this organic manure for cultivation does not only enhance environment quality and attainment of food security but will contribute to local economic development, poverty alleviation and social inclusion as well as, healthy livelihood in particular. Generally, this will lead to increase vegetable production that has less anti-nutritional substance such as safe level of oxalate, low heavy metal values of cadmium and lead for healthy livelihood.

IV. Conclusion

The research shows that varying treatments does not deny the vegetables availability of any nutritional components as it is only the concentration that varies though, organic treat have significantly higher concentration of some nutrient and less of anti-nutritional compounds. Fundamentally, this indicates that vegetables cultivated using poultry and waste soil treatment contains the entire nutritional requirement for human livelihood. The small amount of Oxalate compound found in the four samples is typical of all vegetables however the lower oxalate content in control and organic treatment samples signify that no treatment and organic treatment are still better for human livelihood than chemical treatment. Decomposed waste treatment has the highest concentration of Hg, followed by control while NPK has the least Hg content but not withstanding all the values are above permissible level.

Vegetable should be wash before consumption to reduce heavy metal concentration and its toxic effect for enhance human livelihood.

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