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Evaluation of proximate compositions and heavy metal concentrations of *Amaranthus spinosus* L. and *Talinum fruticosum* (L.) Juss. harvested on some poultry dumpsites in Badagry, Lagos State, Nigeria

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Abstract

Poultry waste as enhancement for crop development has become a norm for nutrients' source but their pollution potentials is a source for concern. Thus, this study aimed at assessing proximate compositions and heavy metal accumulation in organs of *Amaranthus spinosus* and *Talinum fruticosum* handpicked from three poultry faecal sites in Badagry, Lagos State. Leaves and roots of *A. spinosus* and *T. fruticosum* as well as soil samples were collected from Yafin, Agric and Badagry dumpsites in Badagry Local Government and these were subjected to proximate and heavy metal analyses using standard analytical procedures. Data obtained were analyzed using mean-standard deviation. Proximate analyses of *A. spinosus* and *T. fruticosum* from three faecal sites contained appreciable Moisture, protein, carbohydrate, fiber, ash, and fat contents. Also, heavy metal analyses of the vegetables from the three faecal sites ranged as follows: Cd: 0.01-0.05mg/100g in leaves; 0.04-0.12mg/100g in roots; Co: 0.04-0.05 in leaves; 0.04-0.12mg/100g in roots; Cr: 0.58-0.84mg/100g in leaves; 0.91-1.01mg/100g in roots; Cu: 0.27-70.51mg/100g in leaves; 0.50-58.55mg/100g in roots for *A. spinosus*; Cd: 0.04-0.07mg/100g in leaves; 0.06-0.12mg/100g in roots; Co: 0.02-0.06mg/100g in leaves; 0.08-0.34mg/100g in roots; Cr: 0.05-0.12mg/100g in leaves; 0.04-0.23mg/100g in roots; Cu: 61.55-121.81mg/100g in leaves; 48.45-147.45mg/100g in roots for *T. fruticosum* and Cd: 3.53-9.05mg/100g, Co: 0.14-0.69mg/100g, Cr: 0.14-4.22mg/100g; and Cu: 2.59-8.11mg/100g in soils for all three dumpsites sampled. However, all metals analysed were below WHO limits for vegetable and soils except cobalt, copper and chromium. Thus, locals should be advised against consumption of vegetables from dumpsites since toxic substances often accumulates in the environment and maybe hazardous to man's health.

Keywords: Proximate composition, Heavy metals, Accumulation, *Amaranthus spinosus*, *Talinum fruticosum*, Poultry, Dumpsite, Soil



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1.0 Introduction

Poultry farming is a profitable and high-income business due to the huge demand for poultry products such as meat and eggs (Aklilu et al., 2008; Suleiman et al., 2015). Pereira and Vicente (2013) reported that consumers value poultry products often because of its bio-stores of protein and minerals especially iron and zinc. Poultry businesses generate a lot of waste, and the industry needs to figure out how to appropriately manage their wastes. Poorly managed poultry litters can have a serious impact on the ecosystem. This could lead to pollution of the air, surface water, and soil. The most common environmental hazard caused by improper management of poultry litters is nitrogen and phosphorus pollution of surface water (Sims et al., 2005). Pollution often occurs because of seeping and runoff from direct disposal of poultry litter into aquatic bodies and land. Phosphate and nitrogen leaching and decomposition in the litter could cause eutrophication and unpleasant odors. Litter from poultry farms has been shown to include trace quantities of potentially hazardous metals like Arsenic, Cadmium, Copper, and Manganese (Subramanian and Gupta, 2006; Suleiman et al., 2015; Ukpe and Chokor, 2018; Chowdhury et al., 2021).

Nevertheless, proper poultry manure processing and management could supplement or even replace inorganic fertilizers (Tao and Mancl, 2008). Crop production has historically relied on recycled nutrients from poultry manure. Poultry excretes 65.5 % nitrogen, 83.5 % potassium, and 68.5 % phosphorus, all of which contribute to greater crop productivity (Olumayowa and Abiodun, 2011). Some minerals and elements that are absent in inorganic fertilizers are also abundant in poultry droppings, this includes sodium, iron, and many others. Most farms hold manure for at least a month before disposing of it, thus reducing the nitrogen concentration by roughly 40 % and, diminishing its value. In a study by Magagula et al. (2010), Poultry droppings were applied to sweet potato plantation to enhance their yield. The result was not favorable as there was a reduction in tuber development with increased vegetative growth and this was attributed to their nutrient deficiency in supporting the development of tubers.

Vegetables were the obvious choice for this experiment because of their critical role in human health and well-being. Vegetables are impeccable sources of essential nutrients and improves the dietary fractions of individuals (Bamishaiye et al., 2011). Essential minerals are basic ingredients of food needed for functional activities of body tissues (Turan et al., 2003). In addition, Nigeria needs to improve the cultivation of these crops to improve farmers' livelihoods, sustainable agriculture, and food security throughout the country.

Amaranthus spinosus L. is a vegetable commonly called spiny amaranth which belongs to the family Amaranthaceaea, distributed

widely within tropical and subtropical regions of Africa. *A. spinosus* is often consumed as vegetable in soups due to its medicinal and nutritional properties; which includes management of gonorrhea; applied externally to treat eczema, burns, wounds, boils, earache, haemorrhoids and many other notable ailments (Anjali and Nishikant, 2019).

Talinum fruticosum (L.) Juss (water leaf) is a vegetable in the family Taliniaceae and commonly found in the humid tropics which have been reported in many West and Central African countries (Oluwole et al., 2018). Water leaf is eaten as a leaf in soups and stews to compliment the starchy main dishes and enhance the treatment of some ailments such as contusions, inflammations, and tumors; and the phytochemical analysis on *T. fruticosum* revealed that it contains some vital phytochemicals such as tannins, alkaloids, saponins, and flavonoids which complements their potential medicinal and dietary benefits (Iheanacho and Ubebani, 2009; Oluwole et al., 2018).

However, despite the rich medicinal and nutrient sources of these vegetables and the capacity of poultry manure to support the development of plants to supply essential nutrients to the consumers and provide higher remuneration to the farmers respectively. There has been suggested evidence of poultry manures being the sources of metallic and other pollutants to the plants (Adefila et al., 2015), possible interplay between contaminated feeds fed to the poultry birds and the level of contaminants in the plants (Ukpe and Chokor, 2018; Chowdhury et al., 2021), and poverty and ignorance nature of the locals in picking vegetables such as *Amaranthus spinosus* and *Talinum fruticosum* from the wild and dumpsites in Lagos and other parts of the world (Oluwole et al., 2020) for consumption necessitated this study. This study therefore examined proximate compositions and heavy metals' accumulation in *Amaranthus spinosus* and *Talinum fruticosum* as well as soil samples obtained from three poultry disposal sites in Badagry, Lagos State, Nigeria in a bid to discourage the consumption of vegetables growing on poultry dumpsites.

2.0 Materials and Methods

Sample collection

Soils, *A. spinosus* and *T. fruticosum* samples were collected at 10ft from three poultry faecal sites in Badagry Local Government of Lagos State. The specific collection points are Yafin poultry dumpsite (6° 43' 27" N; 2° 86' 79" E), Agric poultry dumpsite (6° 26' 03" N; 2° 52' 28" E), and Badagry poultry dumpsite (6° 42' 70" N; 2° 89' 67" E). Soil samples were also taken from these locations (Figure 1).

Sample Pre-treatment

Roots and leaves of two sampled vegetables were cleaned with running water and drenched in distilled water to excavate soil

particles and other dirt; pulverized to minimize surface moisture content before being oven dried for an hour at 600 °C.

The dried leaves and roots were mashed with an electric blender (Waxer, Model 2387), and packed in polyethene bag. The milled materials were subjected to both proximate and heavy metal methods. The amount of moisture in the sample was determined using fresh leaves and roots. For soil sample, 5g of the air-dried sample was extracted with 50 ml of universal soil extractant [0.374 mol/L of sodium sulfate (Na_2SO_4) and 0.45 mol/L of sodium bicarbonate (NaHCO_3)], by shaking the mixture in a breaker for 30 minutes. Thereafter, the extract was filtered using Whatman 75mm filter paper.

Proximate Analysis

For the moisture content, the leaves and roots were dried to a consistent weight in a Gallenkamp oven at 105 °C (AOAC, 1990). For ash content, methods of Ceirwyn (1995) were employed by dry ashing in lenton muffle furnace at 600 °C till the grayish white ash was achieved. Kjeldahl's nitrogen value was multiplied by a protein factor of 5.3, which is recommended for vegetable analysis, to get the crude protein content. To determine crude lipid concentrations, the petroleum ether (B.P. 60 °C-80 °C) was used as solvent with the aid of soxhlet apparatus, following the directive of AOAC (1990). Acid-base digestion was used to determine the amount of crude fiber in the sample with 1.25% H_2SO_4 (w/v) and 1.25% NaOH (w/v) solutions. The percentage of available carbohydrate was determined by subtracting the percentage of crude protein, crude fat, crude fiber, and ash from 100 (AOAC, 1990).

Heavy Metals Determination by Inductively Coupled Plasma Spectroscopy

Optical-emission spectrometry was used to analyze the sample filtrates for metals using an inductively coupled plasma, optical emission spectrometer (Agilent ICP-OES 710 Axial). The accuracy of the test results was confirmed by comparing them to calibration curves generated using metal standards that had been independently verified (AccuStandard Inc, USA). Quantification of metals in both plants and soils were carried out using the formulae below with the aid of Agilent Expert II software (2010).

a. Quantitation of metal content in the plant samples is given by:

$$\text{Metal in Plant (mg/100g)} = \frac{\text{Metal (mg/L)} \times V_{\text{final}} \times F}{\text{Weight of sample taken (g)}}$$

b. Quantitation of metal content in the soil samples is given by:

$$\text{Metal in Soil (mg/kg)} = \frac{\text{Metal (mg/L)} \times V_{\text{final}}}{\text{Weight of sample taken (g)}}$$

Where:

mg/L = concentration of the nutrient in the digest or extract; F = 0.1=

mg/L = concentration of the nutrient in the digest or extract.

F = 0.1= Factor for conversion to mg/100g

V_{final} = final volume of the digest or extract (ml).

Statistical Analysis

The data analysis was carried out on the triplicate data collected using SPSS (Statistical Package for Social Science 2007) software. Data from proximate and heavy metal analyses were conveyed as mean ± standard deviation.

3.0 Results

Proximate compositions of *Amaranthus spinosus* from Three Poultry Dumpsites

Results of proximate analysis of *Amaranthus spinosus* leaves and roots collected from three poultry dumpsites are shown in Table 1. A succinct consideration of the result showed marked deviation in their proximate compositions. Moisture content of the plant samples from the three locations varied, the root of plant sample harvested at Agric dumpsite has the highest value (80.25%±0.34) in moisture content while the leaf of samples from Yafin dumpsite has the least. In terms of protein quantity, leaf samples from Agric dumpsite had the highest percentage (9.82%±0.13) while the lowest percentage was recorded in the root of Yafin samples. Percentage of fat also varied, with Yafin leaf samples having the highest value (1.08%±0.08) while the root of Badagry sample has the lowest values. Carbohydrate percentage was highest in Yafin root samples (7.01%±1.27), but the lowest percentage was recorded in the leaf of Agric samples. For ash content, variation continues as Yafin leaf sample has the highest content (8.69%±0.03) while the leaf sample from Agric poultry has the lowest. Lastly, root of Badagry sample has the highest fibre (4.20%±0.12), with root of Yafin sample having the least.

Proximate compositions of *Talinum fruticosum* from Three Poultry Dumpsites

Results of proximate analysis of *Talinum fruticosum* leaves and roots collected from three poultry dumpsites are presented in Table 2. There are differences in the moisture contents of the plant samples gotten from the three locations as root sample from Badagry dumpsite had the highest value (80.02%±1.45) in moisture content, and leaf sample of Agric had the least value. For protein, leaf sample from Yafin dumpsite had the highest percentage (4.91%±0.19) while the lowest percentage was recorded in the root of Badagry samples. Percentage of fat also varied, with Badagry leaf samples having the highest value (1.21%±0.13) while the root of Yafin sample had the lowest value. Carbohydrate percentage was highest in Agric. leaf sample (7.44%±0.59), but the lowest percentage was recorded in the root of Yafin samples. For ash content, variation continues as Yafin leaf sample had the highest content (9.91%±0.21) while the root

sample from Agric poultry had the lowest. Lastly, leaf of Yafin samples had the highest fibre ($4.12\% \pm 0.15$), with leaf of Agric sample having the least.

Heavy Metals' Accumulation in *Amaranthus spinosus* from Three Poultry Dumpsites

Heavy metal contents of *Amaranthus spinosus* samples collected from different poultry dumpsites are presented in Table 3. Cadmium concentration in the organs of the plant samples varied, the root of plant samples harvested from Agric dumpsite is the highest ($0.12 \text{ mg}/100\text{g} \pm 0.00$) in Cadmium content while leaf of Badagry samples had the least ($0.01 \text{ mg}/100\text{g} \pm 0.00$). In terms of Cobalt quantity, root of Badagry sample had the highest concentration ($0.10 \text{ mg}/100\text{g} \pm 0.01$) while the lowest concentration ($0.04 \text{ mg}/100\text{g} \pm 0.01$) was recorded in the leaf of Agric. For chromium concentration, highest value was observed in the root of Agric. sample ($1.01 \text{ mg}/\text{Kg} \pm 0.06$), and the lowest value was recorded in the leaf of Yafin sample ($0.08 \text{ mg}/100\text{g} \pm 0.00$). Mean concentration of copper was extremely high in leaf and root of Yafin sample ($70.51 \text{ mg}/100\text{g} \pm 1.34$ and $58.55 \text{ mg}/100\text{g} \pm 2.22$ respectively) when compared to other samples, as the lowest copper concentration was recorded in the leaf of Badagry sample ($0.27 \text{ mg}/100\text{g} \pm 0.04$)

Heavy metals accumulation in *Talinum fruticosum* from three poultry dumpsites.

Talinum fruticosum's heavy metal contents from the different poultry faecal sites are presented in Table 4. Cadmium concentration in the organs of the plant samples varied, the root of plant sample harvested from Agric. dumpsite is the highest ($0.12 \text{ mg}/100\text{g} \pm 0.01$) in Cadmium content while leaf of Badagry sample has the least ($0.04 \text{ mg}/100\text{g} \pm 0.01$). In terms of Cobalt quantity, root of Badagry samples had the highest concentration ($0.34 \pm 0.01 \text{ mg}/100\text{g}$) and the lowest concentration ($0.02 \text{ mg}/\text{Kg} \pm 0.00$) was recorded in the leaf of the same sample. For chromium concentration, highest value was observed in the root of Yafin sample ($0.23 \text{ mg}/100\text{g} \pm 0.01$), and the lowest value was recorded in the root of Badagry samples ($0.04 \text{ mg}/100\text{g} \pm 0.01$). Mean concentration of copper was generally high in all samples, but the highest value was recorded in the root of Agric samples ($147.45 \text{ mg}/100\text{g} \pm 3.65$), as the lowest copper concentration was recorded in the root of Badagry sample.

Heavy Metals' Contents in Soil Samples from Three Poultry Dumpsites

Soil heavy metal contents of samples fetched from the three poultry dumpsites are presented in Table 5. Cadmium concentration was highest in Badagry sample ($9.05 \text{ mg}/100\text{g} \pm 0.18$), while the least was recorded in Yafin samples ($3.53 \text{ mg}/100\text{g} \pm 0.44$). Mean value of cobalt highest in Badagry sample ($9.05 \text{ mg}/100\text{g} \pm 0.18$), while the least was recorded in Yafin samples ($3.53 \text{ mg}/100\text{g} \pm 0.44$). Mean

value of cobalt was highest in Agric. sample ($0.69 \text{ mg}/100\text{g} \pm 0.02$) and lowest in Yafin

sample ($0.14 \text{ mg}/\text{Kg} \pm 0.05$). Agric. soil sample has the highest concentration of chromium ($4.22 \text{ mg}/100\text{g} \pm 0.06$), while Yafin samples has the least ($0.07 \text{ mg}/100\text{g} \pm 0.01$). Furthermore, highest copper content was recorded in Badagry samples and lowest in Yafin samples.

4.0 Discussion

Proximate Analyses of *Amaranthus spinosus* and *Talinum fruticosum*

The two vegetables in this study had different moisture contents across the locations, and higher moisture content than those previously reported by Oluwole et al. (2020) for similar vegetables growing on dumpsites but were lower than those reported by Wang et al. (2021) for some leavy vegetables harvested from horticultural garden. Oluwole et al. (2019) found evidence to support the idea that moisture content varies by location. Variation in soil properties were cited as a cause for this phenomenon. As a result of the high-water content, enzymes soluble in water and coenzymes which improves these two plants' digestion can be more active (Iheanacho and Ubebani, 2009); and higher water contents in food helps in its breakdown in humans and improves bacterial action to act upon it (Khan et al., 2002; Wang et al., 2021). All samples in this study had lower protein content than what Oluwole et al. (2020) reported for the same vegetables on dumpsites. Plants with over 12 percent caloric value in protein has been proven to be an excellent protein bio-store (Ali, 2009). So, these two vegetables are not particularly protein dense. The crude fibre content in this study fell below the documented quantities for certain vegetables in Nigeria (Isong and Idiong, 1997). Constipation, diabetes, and high cholesterol can all be reduced with dietary fiber (Ishida et al., 2000). According to this investigation, the carbohydrate percentages was lower than the values found in (Oluwole et al., 2020). It is impossible to live without energy food source, a key class of naturally occurring organic macromolecules that serves as basic raw substances for numerous industries (Ebun-Oluwa and Alade, 2007). The percentage fat contents in this study were below those in some leafy staples reported in Oluwole et al. (2019) and Wang et al. (2021) but higher than those reported for some vegetable like Pot purslane, Spinach, Turnip, Garlic, Radish, Lady finger, Bath sponge and Brinjal by Bangash et al. (2011) in Pakistan. As the second most important source of energy in human nutrition, lipids are only inferior to carbohydrate. Biosynthesis of steroid hormones, such as cholesterol, requires the use of lipid carbon sources. Essential fatty acids could be obtained from plant triacylglycerol, which has been widely studied

and documented (Lichtenstein, 2014; Hidalgo and Zamora, 2016). Vegetable leaves in this study have minimal fat content, which is beneficial to human health (Rumeza et al., 2006). The percentage ash concentration in the vegetables from the three locations was above

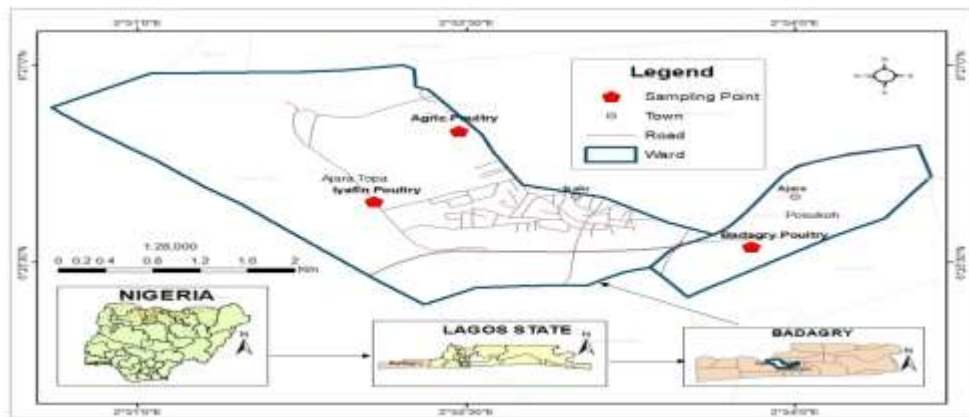


Figure 1: Map showing different poultry dumpsites in Badagry Area, Lagos State.



Figure 2: Images showing different Poultry Dumpsites; A- Badagry dumpsite B- Agric. dumpsite, C-Yafin dumpsite.

Table 1: Proximate compositions of *Amaranthus spinosus* from Three Poultry Dumpsites

Proximate	Organ	Badagry	Yafin	Agric.
Moisture (%)	Leaf	78.46±0.74	77.08±0.16	79.11±0.02
	Root	77.43±0.67	77.69±0.99	80.25±0.34
Protein (%)	Leaf	8.06±0.08	5.08±0.06	9.82±0.13
	Root	6.58±0.18	4.07±0.06	7.68±0.50
Fat (%)	Leaf	0.51±0.03	1.08±0.08	0.73±0.23
	Root	0.42±0.04	0.92±0.03	0.57±0.04
Carbohydrates (%)	Leaf	2.74±0.46	5.57±0.04	2.05±0.14
	Root	3.77±1.51	7.01±1.27	2.41±0.9
Ash (%)	Leaf	6.79±0.12	8.69±0.03	6.17±0.08
	Root	7.62±0.57	8.27±0.08	6.91±0.18
Fibre (%)	Leaf	3.09±0.04	2.51±0.08	2.13±0.13
	Root	4.20±0.12	2.05±0.11	2.15±0.08

Triplicate Values are presented as mean±standard deviation.

Table 2: Proximate Compositions of *Talinum fruticosum* from Three Poultry Dumpsites

Proximate	Organ	Badagry	Yafin	Agric.
Moisture (%)	Leaf	76.18±0.44	76.23±1.06	76.05±0.09
	Root	80.02±1.45	78.98±0.08	79.48±0.78
Protein (%)	Leaf	3.23±0.07	4.91±0.19	4.39±0.25
	Root	3.00±0.04	4.88±0.15	4.04±0.08
Fat (%)	Leaf	1.21±0.13	0.49±0.01	1.04±0.07
	Root	1.10±0.03	0.42±0.06	0.91±0.06
Carbohydrates (%)	Leaf	7.21±0.74	5.32±1.55	7.44±0.59
	Root	4.40±0.72	3.73±0.17	4.53±0.72
Ash (%)	Leaf	8.06±0.09	9.91±0.21	8.29±0.50
	Root	7.91±0.06	9.01±0.09	7.85±0.30
Fibre (%)	Leaf	4.12±0.15	3.15±0.08	2.79±0.33
	Root	3.67±0.770	2.99±0.04	3.20±0.34

Triplicate Values are presented as mean±standard deviation.

Table 3: Heavy Metals' Accumulation in *Amaranthus spinosus* from Three Poultry Dumpsites

Heavy Metal	Organ	Badagry	Yafin	Agric	FAO/WHO PL (2016)
Cadmium (mg/100g)	Leaf	0.01±0.00	0.03±0.00	0.05±0.01	0.20
	Root	0.04±0.01	0.05±0.01	0.12±0.00	
Cobalt (mg/100g)	Leaf	0.05±0.01	0.05±0.01	0.04±0.01	0.01
	Root	0.10±0.01	0.09±0.00	0.09±0.01	
Chromium (mg/100g)	Leaf	0.84±0.08	0.08±0.00	0.58±0.04	2.30
	Root	0.91±0.06	0.1±0.01	1.01±0.06	
Copper (mg/100g)	Leaf	0.27±0.04	70.51±1.34	1.03±0.08	3.0
	Root	0.5±0.04	58.55±2.22	1.98±0.33	

Triplicate Values are presented as mean±standard deviation; PL-Permissible Limits

Table 4: Heavy Metal Accumulation in *Talinum fruticosum* from Three Poultry Dumpsites

Heavy Metal	Organ	Badagry	Yafin	Agric.	FAO/WHO PL (2016)
Cadmium (mg/100g)	Leaf	0.04±0.01	0.07±0.01	0.07±0.01	0.20
	Root	0.06±0.00	0.08±0.00	0.12±0.01	
Cobalt (mg/100g)	Leaf	0.02±0.00	0.06±0.01	0.05±0.01	0.01
	Root	0.34±0.01	0.11±0.00	0.08±0.01	
Chromium (mg/100g)	Leaf	0.05±0.01	0.12±0.02	0.07±0.01	2.30
	Root	0.04±0.01	0.23±0.01	0.09±0.01	
Copper (mg/100g)	Leaf	61.55±7.88	90.03±2.88	124.81±4.64	3.0
	Root	48.45±3.29	108.86±2.89	147.45±3.65	

Triplicate Values are presented as mean±standard deviation; PL-Permissible Limits

Table 5: Heavy Metal Concentrations in Soil samples from Three Poultry Dumpsites

Heavy metal	Badagry	Agric	Yafin	FAO/WHO PL Soils (2011)
Cadmium (mg/100g)	9.05±0.18	8.48±0.18	3.53±0.44	1.40
Cobalt (mg/100g)	0.31±0.03	0.69±0.02	0.14±0.05	50
Chromium (mg/100g)	0.14±0.04	4.22±0.06	0.07±0.01	100
Copper (mg/100g)	8.11±0.13	6.42±0.58	2.59±0.11	100

Triplicate Values are presented as mean±standard deviation; PL-Permissible Limits

those documented by Oluwole et al. (2020). According to Edema and Okiemen (2000), food must have high ash content to account for the mineral elements. As soil inorganic properties and compositions in and around the three locations differed, so too did the proximate composition of the two vegetables in this study and this is supported by the findings of Oluwole et al. (2018).

Heavy Metal Analyses of *Amaranthus spinosus*, *Talinum triangulare* and Soil Samples

Each vegetable had variable levels of heavy metals in roots and leaves, and this shows their differential build-up capacity, as seen in the overall results of the heavy metals' concentration. This may be attributed to a wide range of deposition mechanisms, leaching rates, and surface water flow and the incorporation from the feeds fed to the birds and subsequently excreted and accumulated in the plants and soils of poultry dumpsites (Adefila et al., 2010; Suleiman et al., 2015; Ukpe and Chokor, 2018; Chowdhury et al., 2021). The maximum concentration of heavy metals accumulated by the two vegetables is found at the root of the plant in all places studied; and these findings are comparable to those documented by Ni et al. (2004) and are likely owing to the sluggish movement of heavy metals from the roots to the shoot, which is because of the interplay between soil-plants and root-microbes. However, this study found out that there is a significant difference in concentration of all heavy metals studied between the two vegetables. This difference could be attributed to the fact that plant species and varieties affect heavy metal uptake by vegetables which involved a complex synergistic reaction (Long et al., 2003). Also, concentration of cadmium and chromium were lower than the limits accredited for vegetables by FAO/WHO (2016) as reported in Charrondiere et al. (2016), while cobalt and copper were above the permissible limit, and this could be attributed to the movement of metals within plants' tissues from the soil (Wuana and Okiemen, 2011; Chibuike and Obiora, 2014; Singh et al., 2016).

Reduction in soil metallic compositions (Co, Cr and Cu) was observed in the soil samples from the three poultry dumpsites except cadmium, which was above FAO/WHO (2011) permitted levels for agricultural soils, and this have been attributed to translocation of metallic nutrients from the soil to the plants via root absorption and their bioremediation mechanism (Chibuike and Obiora, 2014; Singh et al., 2016; Netshiongolwe et al., 2020). Also, it was further supported by Chowdhury et al. (2021) that the feeds fed to poultry birds might contained more cadmium than other heavy metals or due to contamination from other sources and subsequent evident in their concentration in the soil. However, soils tested were also found to be within accepted limits for agricultural soils for some metals like Co,

Cr and Cu, and this have been reported, showing that the soil is suitable for planting as reported by Ebong et al. (2007). The concentration of heavy metals in soils is substantially lower than the quantities in plant samples, which is worth highlighting. This could be due to phytoremediation potentials of the plants growing on the soil especially *Talinum triangulare*, as reported by Anyalogbu et al. (2017).

5.0 Conclusion

Results of proximate analyses in this study have shown that vegetables in the studied poultry dumpsites are generally rich in nutrients. However, heavy metal analysis shows that they are not suitable for human consumption because of the risk of cobalt, copper and chromium toxicity. Also, the soil in these areas may not be excellent for growing crops because heavy metal concentrations usually varied in relation to location. As these dangerous compounds continue to accumulate, it is imperative that they are monitored on a regular basis to ensure that no harm comes to humans or the environment. Additionally, the public need to be aware of the dangers of eating crops grown in these places (poultry dumpsites) as well as the sources of their poultry manures when farmers are planting to avoid contaminations.

Conflict of Interest

Authors declared that there is no conflict of interest.

Author Contributions

Conception: [SOO, MLO, OKO]

Design: [MLO, SOO]

Execution: [MLO, QU, COZ, FOA]

Interpretation: [MLO, COZ, FAO]

Writing the paper: [MLO, QU, SOO]

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