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Research Article

Comparative Evaluation of Proximate Compositions and Heavy Metal Profiles of Three Vegetables Collected in Some Locations in Ikorodu, Nigeria

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Abstract

Vegetables are bio-stores of nutrients required for the effective and smooth running of human body. However, due to soil pollution, vegetables grown often take up heavy metals which cause damages to vital organs in the body. Thus, this research aimed at comparatively assessing the proximate compositions and heavy metal profiles' of *Talinum triangulare, Corchorus olitorius and Solanum macrocarpon* collected from farmlands, roadsides, and markets in some locations in Ikorodu, Lagos State, Nigeria. Leaves of *S. macrocarpon, C. olitorius and T. triangulare* were collected from farmlands, markets, and roadsides across three different locations in Ikorodu; proximate and heavy metal assessments were done using Atomic Absorption Spectrometry. Data obtained were subjected to mean-standard deviation; means were separated using analysis of variance (P≤0.05). Proximate analyses revealed that the vegetables contain appreciable moisture, lipid, ash, protein, fiber, and carbohydrate quantities. Heavy metal analysis revealed the ranges of Zn (0.2746-0.4710mg/Kg), Co (0.0004-0.0007mg/Kg), Cu (0.0442-0.0760mg/Kg) and Mn (0.0002-0.0008mg/Kg) for farmlands; Zn (0.2746-0.5271mg/Kg), Co (0.0004-0.0008mg/Kg), Cd (0.0006mg/Kg), Cu (0.0320-0.1061mg/Kg) and Mn (0.0003-0.0008mg/Kg) for markets; Zn (0.3403-0.5610mg/Kg), Cu (0.0361-0.0930mg/Kg) and Mn (0.0002-0.0008mg/Kg) for roadsides. Pb and Ni were not detected in the vegetables across different locations. Also, all the metals studied were within World Health Organization's permissible limits. This may be due to the regulation of heavy metal availability in plants by the metal matrix concentration in soils. The study, however, suggest that areas with a high concentration of industrial factories and busy roads should not be used for vegetable cultivation to limit plant uptake of heavy metals discharged into the soil.

Keywords: *Proximate, Heavy Metal, Vegetables.*

Introduction

The literature shows that the demand and consumption of vegetables is increasing dramatically all over the world as they constitute an essential component of the human diet and nutrition (Sachdeva, *et al*., 2013; Shaheen, *et al*., 2016). They supply a wide range of nutrients vital to human health and development. Many leafy greens also protect against colon cancer and other harmful substances in the digestive process, thereby reducing one's risk of developing a host of health problems (Chopra and Pathak, 2015). Vegetables are particularly important in terms of ensuring food safety and nutrient quality levels since they include both essential and non-essential nutrients (Gupta, *et al*., 2008). However, it has been observed that, especially in developing nations, the majority of commercially available vegetables are generally cultivated in urban and suburban

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regions of big cities (Sangster, *et al*., 2012; Sultana, *et al*., 2017). Thus, these veggies are subjected to anthropogenic pollution from a variety of sources such as urban and industrial wastes, vehicular emissions, mining, smelting, and metallurgical industries (Kachenko, *et al*., 2006; Mekonnen, *et al*., 2014). Clearly, this indicates that concerns about food safety and the accompanying risks to the public have been widespread (Gizaw, 2019).

Heavy metals are a type of environmental contaminant that has received a lot of attention because of the catastrophic health implications they can have on humans when accumulated in a quantity over what the body requires (Ugulu, 2015; Wang, *et al*., 2018). One of the most significant ways that people are subjected to hazardous metals is via the consumption of contaminated foods and veggies (Ahmad and Goni, 2010). Heavy metals, like Cu, Cd, Pb, Zn, and Mn, are easily absorbed by the tissue of several crops, including jute, spinach, waterleaf, and carrots. When plants are grown in contaminated soils, they tend to absorb more of these metals (Yang, *et al*., 2011). As they move up the food chain, heavy metals become increasingly concentrated in human bodies. Vegetables grown in urban and suburban regions around the world have been found to have high ranges of heavy metal pollution (Chabukdhara, *et al*., 2016; Sultana, *et al*., 2017). This strongly suggests that heavy metals are leaching into the soil and contaminating the vegetables grown in urban and suburban regions. Both the prevalence and severity of contamination have been shown to be higher in underdeveloped countries than in industrialized ones (Cai, *et al*., 2015). Heavy metal pollution around roadsides and farmlands in these regions can be assessed using vegetation and soil samples (Ma, *et al*., 2018; Masoudi, *et al*., 2020). Hence, this research was conducted to evaluate the proximate composition and heavy metal accumulation capability of several vegetables (*Corchorus olitorius*, *Solanum macrocarpon* and *Talinum triangulare*) growing along roadsides, farmlands as well as those collected from marketplaces in some locations within Ikorodu, Lagos State, Nigeria.

Materials and Methods

Sample Collection

Samples of *Solanum macrocarpon, Corchorus olitorius and Talinum triangulare* were handpicked randomly from three different Local Community Development Areas in Ikorodu Local Government, Lagos State, Nigeria. Specific points of collection were roadside, farmland, and marketplace in Ikorodu North (Odoguyan), Ikorodu West (Igbogbo) and Ikorodu central (Bayeku). Samples were collected into a clean polythene bag, well labeled with plant type and location for laboratory analyses.

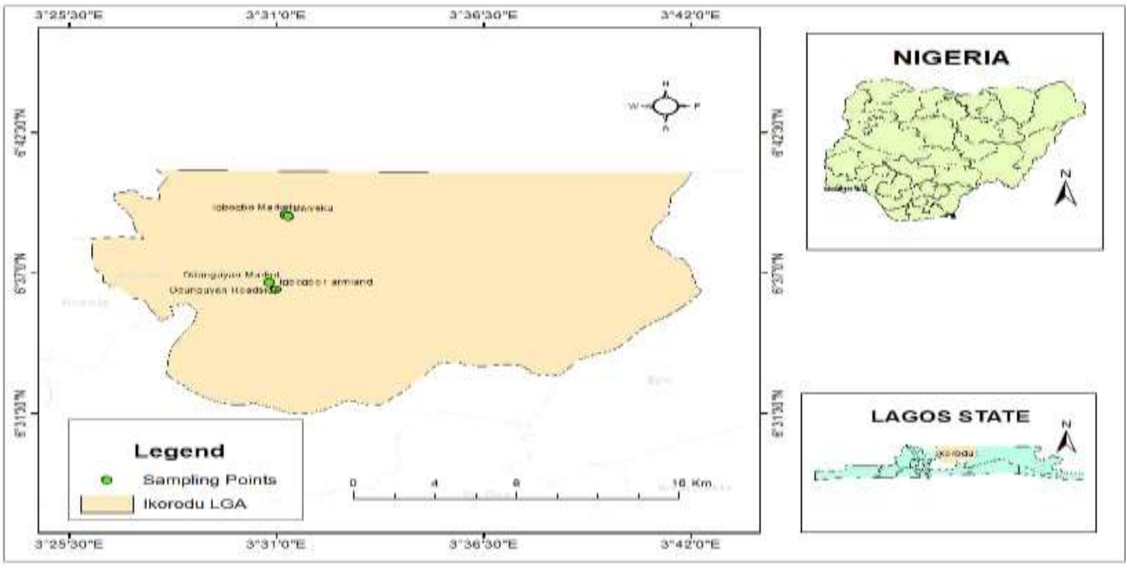

Figure 1: Map of Nigeria showing sample locations

Preparation of Sample for Heavy Metal Analysis

According to the official technique of examination described by AOAC (1995), the veggies were placed at 65^{o}C for 24 hours to remove excess moisture. The samples' leaves were extracted and then blended into a fine powder for analysis. Under a fume hood, 10 milliliters of concentrated HCl, 5 milliliters of concentrated H_2SO_4, and 15 milliliters of concentrated HNO_3 were added to a beaker containing 2 grams of each sample and stirred. Constant heating of the mixture led to the formation of a dense fume, after which the solution was cooled, filtered through Whatman 42 filter paper, and brought to volume with distilled water in a 50 ml volumetric flask. The filtrate was analyzed for the presence of heavy metals.

Heavy Metal Analysis

Heavy metal concentrations in the vegetables were determined by dissolving the ash from dry ashing the samples at 650°C into a solution of distilled deionized water in a flask. In accordance with AOAC (1995) guidelines, an atomic absorption spectrophotometer (Buck Scientific Model 200A) was used to determine the concentrations of all the metals (Pb, Co, Cd, Cu, Mn, and Ni).

Preparation of Sample for Proximate Composition Analysis

Samples for proximate composition analysis were prepared using Oluwole, *et al.* (2021) method. Leaves were removed from the vegetables and rinsed in distilled water. After that, the leaves were sliced thinly, and then chlorine concentrated solution was added for treatment. These samples are then placed in the oven at a temperature of 30ºC for 24 hours to get dried. A blender was used to make a fine powder, and then the samples were stored in an air-tight container. The proximate composition was determined by weighing and extracting each sample (100 g) with methanol.

Proximate Analysis

Standard AOAC, (2005) procedures were used for the proximate analysis of moisture, ash, crude fiber, and fat in the samples of vegetables. Micro-kjeldahl technique, as reported by Pearson (1976), was used to produce a proximate analysis of nitrogen, and the percentage nitrogen was then multiplied by 6.25 to give the crude protein content. Carbohydrate proximate analysis was achieved through a process of differentiation. The procedures were done in triplicates.

Statistical Analysis

The software SPSS 2007 version 20 was used for the univariate statistical analysis on triplicate data using mean-standard deviation, and analysis of variance (ANOVA) was used to compare means.

Results

Proximate Analysis of Vegetables Collected from Different Location in Odongunyan, Ikorodu

The result of the proximate analysis of vegetables collected from the farmland, market and roadside as shown in Table 1 are as follow. *T.triangulare* collected from the market had the highest significant (P≤0.05) moisture content, while *C.olitorius* collected from the market had the lowest moisture content. *S. macrocarpon* collected from the farmland had the highest significant (P≤0.05) significant (P≤0.05) lipid content, while *T. triangulare* collected from the market had the lowest significant (P≤0.05) lipid content. *C. olitorius* collected from the farmland and the roadside had similar significant (P≤0.05) ash content value. *S. macrocarpon* collected from the farmland had the highest significant (P≤0.05) ash content, while *T. triangulare* collected from the farmland had the lowest significant (P≤0.05) ash content (Table 1). *S. macrocarpon* collected from the market had the highest significant (P≤0.05) protein content, while *C.olitorius* collected from the roadside had the lowest significant (P≤0.05) protein content. Crude fiber of *S. macrocarpon* collected from the farmland, market and roadside had significant (P≤0.05) similar values. Also, Crude fiber of *C. olitorius* collected from the farmland, market and roadside had significant (P≤0.05) similar values. *C. olitorius* collected from the farmland and the roadside had significant (P≤0.05) similar ash content value (Table 1). *C. olitorius* collected from the market had the highest significant (P≤0.05) carbohydrate content, while *T. triangulare* collected from the market had the lowest significant (P≤0.05) carbohydrate content.

Table 1: Proximate composition (%) of vegetables collected from different locations in Odongunyan

Vegetable	Location	Moisture (%)	Lipid (%)	Ash (%)	Protein (%)	Crude Fiber (%)	Carbohydrate (%)
S.macrocarpon	Farmland	64.06±0.95[a]	2.08±0.08[a]	0.85±0.04[a]	7.90±0.20[a]	4.00±0.13[b]	21.12±1.32[d]
	Market	57.50±1.34[b]	1.76±0.05[b]	0.51±0.02[c]	8.27±0.09[a]	4.02±0.17[b]	27.95±1.64[b]
	Roadside	65.85±0.82[a]	1.71±0.04[b]	0.73±0.03[a]	7.04±0.14[b]	4.07±0.12[b]	20.61±0.84[c]
C.olitorius	Farmland	64.84±0.75[a]	1.86±0.03[a]	0.54±0.03[c]	4.35±1.41[c]	5.72±0.15[a]	20.61±0.83[c]
	Market	56.71±0.71[b]	1.59±0.05[c]	0.61±0.03[b]	2.88±0.99[d]	5.92±0.08[a]	31.65±1.56[a]
	Roadside	61.14±1.02[b]	1.71±0.45[b]	0.56±0.02[c]	2.88±0.99[d]	5.81±0.11[a]	27.90±0.28[b]
T.triangulare	Farmland	66.31±1.33[a]	1.04±0.02[d]	0.28±0.03[d]	7.21±2.84[b]	3.55±0.13[d]	21.59±4.23a
	Market	67.64±0.93[a]	0.74±0.02[d]	0.49±0.04[d]	7.43±2.66[b]	4.20±1.28[c]	20.26±1.80[d]
	Roadside	61.38±0.72[a]	1.49±0.04[d]	0.79±0.04[a]	6.74±2.68[b]	3.51±0.73[d]	26.06±3.50[b]

Means ± S.D (%) in the same column that do not have similar alphabets at P≤0.05 are significantly different according to one-way Analysis of Variance (ANOVA-1)

Proximate Analysis of Vegetables Collected from different Locations in Igbogbo, Ikorodu

The result of the proximate analysis of vegetables collected from the farmland, market and roadside as shown in Table 2 are as follow. The moisture content of *T. triangulare* collected from the farmland, market and roadside had significant (P≤0.05) similar value. *C. olitorius* collected from the market had the lowest significant (P≤0.05) moisture content. The lipid contents of *S. macrocarpon* and *C. olitorius* collected from the farmland, market and roadside had significant (P≤0.05) similar value (Table 2). *T. triangulare* collected from the farmland had the highest significant (P≤0.05) ash content, while T. triangulare collected from the market had the lowest significant (P≤0.05) ash content. The protein content of *T. triangulare* collected from the farmland, market and roadside had significant (P≤0.05) similar value. *C. olitorius* collected from the roadside had the lowest protein figure. *O. olitorius* collected from the farmland had the highest crude fiber content, while *T. triangulare* collected from the farmland had the lowest significant (P≤0.05) ash content. *C. olitorius* collected from the market had the highest significant (P≤0.05) carbohydrate content, while *T. triangulare* collected from the roadside had the lowest significant (P≤0.05) carbohydrate content.

Proximate Analysis of Vegetables Collected from different Locations in Bayeku, Ikorodu

The result of the proximate analysis of vegetables collected from the farmland, market and roadside as shown in Table 3 are as follow. The moisture content of *S. macrocarpon*, *C. olitorius* and *T. triangulare* collected from the farmland, market and roadside had significant (P≤0.05) similar values. The lipid content of S. *macrocarpon, C. olitorius* and *T. triangulare* collected from the farmland, market and roadside had significant (P≤0.05) similar mean values. The ash content of *S. macrocarpon* collected from the farmland, market and roadside had similar significant (P≤0.05) mean value (Table 3). The protein content of *S. macrocarpon* and *C. olitorius* collected from the farmland, market and roadside had significant (P≤0.05) similar mean value. *T. triangulare* collected from the market had the highest value for protein. *C. olitorius* collected from the roadside had the highest significant (P≤0.05) crude fiber content, while *T. triangulare* collected from the roadside had the lowest significant (P≤0.05) crude fiber content. *S. macrocarpom* collected from the roadside had the highest significant (P≤0.05) carbohydrate content, while *T. triangulare* collected from the market had the lowest carbohydrate content.

Heavy Metal Analysis of Vegetables Collected from various Locations in Odongunyan, Ikorodu

The result of the heavy metal analysis of vegetables collected from the farmland, market and roadside as shown in Table 4 are as follow. *C. olitorius* obtained from the farmland had the highest significant (P≤0.05) concentration of Zinc (Zn). *S. macrocarpon* obtained from the farmland has the lowest significant (P≤0.05) concentration of Zn. Lead (Pb) was not detected in any of the vegetables obtained from farmland, market, and roadside. *S. macrocarpon* obtained from the market has the highest significant (P≤0.05) concentration of cobalt (Co). Cobalt (Co) was not detected in *S. macrocarpon* obtained from the farmland and market, *C. olitorius* obtained from the market and roadside, and *T. triangulare* obtained from the roadside. Cadmium (Cd) was only detected in *T. triangulare* obtained from the market and was not detected in *S. macrocarpon* and *C.olitorius* (Table 4). *C. olitorius* obtained from the market had the highest significant (P≤0.05) concentration of copper (Cu), while *C. olitorius* obtained from the roadside had the lowest significant (P≤0.05) concentration of copper (Cu). *C. olitorius* obtained from the farmland had the highest significant (P≤0.05) concentration of Manganese (Mn), while C. olitorius obtained from the roadside had the lowest concentration significant (P≤0.05) of Manganese (Mn). Nickel (Ni) was not detected in any of the vegetables obtained from farmland, market, and roadside (Table 4).

Table 2: Proximate composition (%) of vegetables collected from different locations in Igbogbo L.C.D.A

Vegetable	**Location**	**Moisture (%)**	**Lipid (%)**	**Ash (%)**	**Protein (%)**	**Crude Fiber (%)**	**Carbohydrate (%)**
S.macrocarpon	Farmland	60.32 ± 0.80^{b}	2.41 ± 0.22^{a}	0.79 ± 0.21^{a}	6.64 ± 1.58^{c}	5.83 ± 2.15^{b}	24.02 ± 1.32^{a}
	Market	59.80 ± 0.67^{b}	2.27 ± 0.38^{a}	0.48 ± 0.75^{c}	8.05 ± 0.96^{b}	4.62 ± 1.32^{c}	24.79 ± 0.99^{a}
	Roadside	62.60 ± 0.83^{b}	2.19 ± 0.93^{b}	0.71 ± 0.16^{a}	6.61 ± 1.19^{c}	5.70 ± 0.49^{b}	22.20 ± 0.37^{b}
C. olitorius	Farmland	62.43 ± 0.65^{b}	2.36 ± 0.33^{a}	0.50 ± 0.13^{b}	6.78 ± 0.55^{c}	7.02 ± 0.65^{a}	20.92 ± 0.41^{b}
	Market	59.63 ± 1.08^{b}	2.17 ± 0.36^{a}	0.49 ± 0.22^{a}	6.83 ± 0.81^{a}	5.53 ± 0.88^{b}	25.35 ± 1.42^{a}
	Roadside	63.42 ± 0.58^{b}	2.26 ± 0.32^{a}	0.55 ± 0.81^{b}	5.72 ± 0.66^{c}	5.14 ± 0.62^{c}	22.92 ± 0.52^{b}
T.triangulare	Farmland	67.82 ± 1.07^{a}	1.37 ± 0.21^{c}	0.25 ± 0.06^{d}	9.54 ± 1.14^{a}	2.51 ± 0.37^{d}	18.52 ± 1.38^{bc}
	Market	67.93 ± 1.41^{a}	0.89 ± 0.11^{c}	0.52 ± 0.15^{b}	10.06 ± 1.96^{a}	3.08 ± 0.53^{d}	17.57 ± 0.79^{bc}
	Roadside	66.68 ± 0.71^{a}	1.81 ± 0.23^{b}	0.81 ± 0.19^{a}	9.19 ± 1.16^{a}	2.14 ± 0.71^{d}	19.55 ± 0.56^{c}

Means ± S.D (%) in the same column that do not have similar alphabets at P≤0.05 are significantly different according to one-way Analysis of Variance (ANOVA-1)

Table 3: Proximate composition (%) of vegetables collected from different locations in Bayeku L.C.D.A

Vegetables	**Locations**	**Moisture (%)**	**Lipid (%)**	**Ash (%)**	**Protein (%)**	**Crude Fiber (%)**	**Carbohydrate (%)**
S. macrocarpon	Farmland	60.72 ± 0.29^{b}	0.92 ± 0.03^{ab}	2.19 ± 0.54^{a}	9.55 ± 0.29^{c}	0.88 ± 0.55^{b}	25.75 ± 0.75^{a}
	Market	60.85 ± 0.63^{b}	0.67 ± 0.03^{b}	2.27 ± 0.39^{a}	9.11 ± 0.32^{c}	1.17 ± 0.68^{ab}	25.93 ± 0.14^{a}
	Roadside	60.1 ± 1.19^{b}	0.62 ± 0.07^{bc}	2.06 ± 0.20^{a}	10.07 ± 0.26^{bc}	1.11 ± 0.46^{ab}	26.13 ± 1.04^{a}
C. olitorius	Farmland	62.06 ± 0.21^{ab}	0.82 ± 0.08^{b}	1.12 ± 0.97^{c}	10.93 ± 0.27^{ab}	0.83 ± 0.67^{b}	24.23 ± 0.48^{b}
	Market	60.79 ± 0.59^{b}	0.62 ± 0.13^{bc}	1.21 ± 0.09^{c}	10.44 ± 0.78^{bc}	1.04 ± 0.64^{b}	25.90 ± 0.46^{a}
	Roadside	60.26 ± 0.65^{b}	0.83 ± 0.67^{b}	1.23 ± 0.19^{c}	10.45 ± 0.27^{bc}	1.90 ± 1.12^{a}	25.33 ± 0.78^{a}
T.triangulare	Farmland	61.14 ± 0.32^{ab}	0.68 ± 0.81^{bc}	1.91 ± 0.12^{ab}	12.56 ± 0.80^{a}	1.07 ± 0.54^{a}	25.60 ± 0.80^{a}
	Market	62.36 ± 0.60^{ab}	0.52 ± 0.06^{c}	1.58 ± 0.16^{bc}	12.75 ± 1.57^{a}	1.29 ± 1.41^{a}	21.48 ± 0.34^{c}
	Roadside	60.95 ± 0.59^{b}	0.59 ± 0.08^{c}	1.62 ± 0.35^{b}	12.32 ± 0.60^{a}	0.99 ± 0.55^{ab}	23.51 ± 1.18^{b}

Means ± S.D (%) in the same column that do not have similar alphabets at P≤0.05 are significantly different according to one-way Analysis of Variance (ANOVA-1)

Table 4: Heavy metal contents (mg/100g) of vegetables collected from different location in Odongunyan L.C.D.A

Vegetable	Location	Zn	Pb	Co	Cd	Cu	Mn	Ni
S. macrocarpon	Farmland	0.23±0.002[a]	ND	ND	ND	0.05±0.000[a]	0.001±0.000[a]	ND
	Market	0.52±0.001[b]	ND	0.001±0.000[a]	ND	0.06±0.000[b]	0.0003±0.000[a]	ND
	Roadside	0.51±0.001[b]	ND	ND	ND	0.08±0.007[a]	0.0003±0.001[a]	ND
C. olitorius	Farmland	0.67±0.09[a]	ND	0.0004±0.00[a]	ND	0.08±0.012[a]	0.0007±0.040[a]	ND
	Market	0.44±0.06[c]	ND	ND	ND	0.52±0.005[b]	0.0006±0.001	ND
	Roadside	0.56±0.07[b]	ND	ND	ND	0.04±0.070[a]	0.0002±0.000[a]	ND
T.triangulare	Farmland	0.30±0.01[d]	ND	0.001±0.00[a]	ND	0.05±0.010[a]	0.0003±0.000[a]	ND
	Market	0.33±0.004[d]	ND	0.004±0.00[a]	0.001±0.00[a]	0.08±0.003[a]	0.0005±0.001[a]	ND
	Roadside	0.34±0.002[d]	ND	ND	ND	0.05±0.000[a]	0.0005±0.000[a]	ND
FAO/WHO (2007)		**99.4**	**0.3**	**0.01**	**0.2**	**73.3**	**500**	**0.10**

Means ± S.D (%) in the same column that do not have similar alphabets at P≤0.05 are significantly different according to one-way Analysis of Variance (ANOVA-1);

ND- Not Detected

Heavy Metal Analysis of Vegetables Collected from Various Locations in Igbogbo, Ikorodu

The result of the heavy metal analysis of vegetables collected from the farmland, market and roadside as shown in Table 5 are as follow. *S. macrocarpon* obtained from the roadside has the highest significant (P≤0.05) concentration of Zinc (Zn), while *S. macrocarpon* obtained from the farmland had the lowest significant (P≤0.05) concentration of Zinc (Zn). Lead (Pb) was not detected in any of the vegetables obtained from the farmland, markets, and roadside. *T. triangulare* contained from the farmland had the highest significant (P≤0.05) concentration of cobalt (Co). Cobalt (Co) was not detected in *S. macrocarpon* obtained from the farmland and roadside, *C. olitorius* obtained from the market and roadside, and *T. triangulare* obtained from the roadside (Table 5). Cadmium (Cd) was not detected in any of the vegetables obtained from the farmland, market and roadside. *T. triangulare* obtained from the market has the highest significant (P≤0.05) concentration of Copper (Cu), while *C. olitorius* obtained from the roadside had the lowest significant (P≤0.05) concentration of Copper (Cu). *C. olitorius* obtained from the farmland has the highest significant (P≤0.05) concentration of Manganese (Mn), while *C. olitorius* obtained from the roadside and *S. macrocarpon* obtained from the farmland had the lowest significant (P≤0.05) concentration of Manganese (Mn) (Table 5). Nickel (Ni) was not detected in any of the vegetables obtained from the farmland, market, and roadside.

Table 5: Heavy metal contents (mg/100g) of vegetables collected from different locations in Igbogbo

Vegetable	Location	Zn	Pb	Co	Cd	Cu	Mn	Ni
S. macrocarpon	Farmland	0.29±0.003^{b}	ND	ND	ND	0.04±0.000^{b}	0.0002±0.000^{b}	ND
	Market	0.48±0.003^{b}	ND	0.01±0.000^{b}	ND	0.06±0.000^{b}	0.0003±0.001^{b}	ND
	Roadside	0.53±0.003^{b}	ND	ND	ND	0.07±0.001^{b}	ND	ND
C. olitorius	Farmland	0.45±0.001^{b}	ND	0.01±0.000^{b}	ND	0.06±0.009^{b}	0.001±0.000^{b}	ND
	Market	0.52±0.001^{b}	ND	ND	ND	0.52±0.001^{b}	0.0006±0.000^{a}	ND
	Roadside	0.48±0.030^{b}	ND	ND	ND	0.04±0.001^{b}	0.0002±0.000^{b}	ND
T.triangulare	Farmland	0.31±0.001^{b}	ND	0.001±0.000^{b}	ND	0.05±0.001^{b}	0.0004±0.001^{b}	ND
	Market	0.31±0.004^{b}	ND	0.001±0.000^{b}	ND	0.08±0.001^{b}	ND	ND
	Roadside	0.36±0.002^{b}	ND	ND	ND	0.05±0.001^{b}	ND	ND
FAO/WHO (2007)		**99.4**	**0.3**	**0.01**	**0.2**	**73.3**	**500**	**0.10**

Means ± S.D (%) in the same column that do not have similar alphabets at P≤0.05 are significantly different according to one-way Analysis of Variance (ANOVA-1); ND- Not Detected

Heavy Metal Analysis of Vegetables Collected from Various Locations in Bayeku, Ikorodu

Table 6 shows the heavy metal analysis of vegetables collected from the farmland, market, and roadside in Bayeku, Ikorodu. The results revealed that *S. macrocarpon* obtained from the roadside has the highest significant (P≤0.05) concentration of Zinc (Zn), while *C. olitorius* obtained from the roadside had the lowest significant (P≤0.05) concentration of Zinc (Zn). Lead (Pb), Cobalt (Co), Cadmium (Cd) and Nickel (Ni) was not detected in any of the vegetables obtained from the farmland, market, and roadside (Table 6). *T. triangulare* obtained from the market has the highest significant (P≤0.05) concentration of Copper (Cu), while *C. olitorius* obtained from the market had the lowest significant (P≤0.05) concentration of Copper (Cu). Manganese was only detected in *S. macrocarpon* obtained from the market and was not detected in *C. olitorius* and *T. triangulare* obtained from the farm, market, and roadside.

Table 6: S.D of heavy metal contents (mg/100g) of vegetables collected from different locations in Bayeku

Vegetable	Location	Zn	Pb	Co	Cd	Cu	Mn	Ni
S. macrocarpon	Farmland	0.38±0.009[b]	ND	ND	ND	0.06±0.001[b]	ND	ND
	Market	0.60±0.010[a]	ND	ND	ND	0.07±0.009[b]	0. 003±0.000[b]	ND
	Roadside	0.66±0.010[a]	ND	ND	ND	0.09±0.009[a]	ND	ND
C. olitorius	Farmland	0.47±0.010[b]	ND	ND	ND	0.06±0.009[b]	ND	ND
	Market	0.31±0.050[c]	ND	ND	ND	0.03±0.004[c]	ND	ND
	Roadside	0.45±0.060[b]	ND	ND	ND	0.03±0.010[c]	ND	ND
T.triangulare	Farmland	0.41±0.004[b]	ND	ND	ND	0.07±0.002[b]	ND	ND
	Market	0.40±0.001[b]	ND	ND	ND	0.11±0.003[a]	ND	ND
	Roadside	0.46±0.002[b]	ND	ND	ND	0.07±0.000[b]	ND	ND
FAO/WHO (2007)		**99.4**	**0.3**	**0.01**	**0.2**	**73.3**	**500**	**0.10**

Means ± S.D (%) in the same column that do not have similar alphabets at P≤0.05 are significantly different according to one-way Analysis of Variance (ANOVA-1);
ND- Not Detected

Discussion

Proximate Analyses of Vegetables across the Three Sampled Locations

Proximate analyses of the three vegetables sourced from three different locations are shown in Tables 1-3. The carbohydrate content of the vegetables collected from different farmlands across the three locations ranges from 19.55-25.75%. The carbohydrate constituent of the veggies collected from different markets across the three locations ranges from 18.52-31.65% while the carbohydrate component of the veggies collected from different roadsides across the three locations ranges from 17.57-26.06%. These data are lower than what was reported for carbohydrates in vegetables by Ndlovu and Afolayan, (2008) but conform to those documented by Oulai, *et al*., (2014). The moisture contents of the vegetables collected from different farmlands across the three locations ranges from 60.32-66.68%. The moisture content of the vegetables collected from different markets and roadside across the three locations ranges from 56.71-67.93% and 60.10- 66.68% respectively. These are more than those documented by Onwordi, *et al*., (2009). The lipid contents of vegetables collected from the market, farmland, and roadside in Bayeku ranged from 0.52-0.92%, which is like the report of Islam, (2013). The lipid content of vegetables collected from the market, farmland, and roadside in Odongunyan and Igbogbo ranged from 0.74-2.41%, which are like report of Adeleke and Abiodun, (2010). The leaves of vegetables are low in lipid content which makes them suitable for consumption (Rumeza, *et al*., 2006). The protein content of *S. macrocarpon* collected from the farmland, markets, and roadside ranges from 5.79% to 9.55%. The values are higher than the research reported on the protein content of two varieties of *S. macrocarpon* by Agoreyo, *et al*., (2012). Ali, (2009) reported that plant-based foods that provide the body with 12 percent of its caloric needs in protein are essential protein sources. Therefore, the vegetables examined in this study are not essential protein sources. The crude fiber content of vegetables collected at various points across the three locations varies between 0.83 and 7.02 percent. This demonstrated that the collected species have enough fibre component, which has the capability to promote a healthy lifestyle by lowering the risk of major diseases like coronary heart disease, constipation, and diabetes (Taiga, *et al*., 2008). This study collected vegetables with an ash content ranging from 0.25 to 2.27 percent. Generally variations in the proximate composition of vegetables across different locations are impacted by a range of factors, including water and soil mineralization (Oluwole, *et al*., 2020).

Heavy Analysis of Vegetables across the Three Sampled Locations

Kidney and bone damage, as well as a possible carcinogenic effect, have all been linked to cadmium exposure, making it a serious health risk (Suruchi and Pankaj, 2011). Cadmium's adverse effects, including kidney damage and insufficient urine excretion of proteins, were also described by Guerra, *et al*., (2012) in individuals aged 16–33 whose metabolism of the metal was incomplete. In this present study, only *T. triangulare* bought at the Odongunyan market contained detectable levels of cadmium (Cd), at 0.0006mg/kg. This concentration is below the permissible level of 0.02 mg/kg as stated by the WHO/FAO (2007). Therefore, it is reasonable to assume that, at the present time, cadmium contamination in vegetables from these regions does not pose any health risks to consumers.

Zinc, on the other hand plays a crucial role in many enzymes and helps maintain the molecular structure of membranes, making it an indispensable component of all living things (WHO, 1996). It's involved in the synthesis and metabolism of carbohydrates, proteins, and fats. Metals like copper can have their metabolism messed with by zinc (WHO, 1996). Rapid zinc absorption by plants grown in contaminated soil leads to human consumption of the metal. Numerous health issues, such as vascular shock, dyspeptic nausea, pancreatitis, and damage to the hepatic parenchyma, have been linked to excessive Zn intake in both humans and animals (Odebunmi, *et al*., 2004; Salgueiro, *et al*., 2000). Hambidge (1987) found that a lack of zinc could cause humans to develop slowly and cause a delay in sexual maturity. WHO/FAO (2007) advised a maximum limit of 99.4 mg/kg for zinc in vegetables. Zinc concentration in vegetables analyzed in this study are significantly below this limit indicating that they provide no toxicological risk due to zinc compounds.

In patients with nephritis, cancer, and chronic infections, cobalt elevates hemoglobin levels. According to the Food and Nutrition Board (2004), the average adult consumes between 2.5 and 3.0 mg of cobalt per day, and the WHO/FAO (2007) have established a safe limit of 0.01 mg/kg for cobalt in vegetables. In this current study, concentrations were found to be below the threshold for safety, indicating that there is no toxicological risk to humans from eating these vegetables.

Humans require copper (Cu) as a component of metalloproteins and enzymes, but too much of this mineral can lead to major health issues such anemia, diabetes, inflammation, kidney and liver malfunction, and a deficiency of vitamin C (Lokeshappa, *et al*., 2012). According to the WHO/FAO (2007), 73.3 mg/kg of copper is considered safe for consumption in vegetables. The highest copper levels found in vegetables studied were well below the recommended maximums, so eating them poses no risk of illness typically associated with eating foods with excessively high levels of copper. Copper's metabolism is aided by molybdenum and zinc, and the metal is generally safe for human consumption because of this. When harvesting vegetables, farmers and collectors should avoid obtaining their supplies from soils and environments containing high concentrations of molybdenum and zinc (Oladele and Fadare, 2015).

Humans require manganese (Mn) because it is essential to the production of hemoglobin (Sekeroglu, *et al*., 2006). Below the 500 mg/kg safe limit reported by (WHO/FAO, 2007), all the vegetables tested are free of toxicity from Manganese. Furthermore, no traces of lead (Pb) or nickel (Ni) were detected in any of the three regions' vegetable sampled. As a result, it can be said that the vegetables gathered from these areas are safe for consumption.

Conclusion

Findings of this work showed that *S. macrocarpon, C. olitorius and T. triangulare* are good sources of nutrient such as, carbohydrate, crude fiber, ash, and lipid to the human body. Also, it could be inferred that the vegetables are free of heavy metal toxicity because all metals analyzed are below safe limits. However, vegetables should not be grown in areas characterized by high density of industrial activities and busy roads; to reduce the tendency of heavy metals accumulation.

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