



Comparative Study of Nutrient Values and Heavy Metals Content of *Corchorus olitorius* Collected from Farm Land (Post Service) and Dumpsite (Okofili) In Lagos, Nigeria.

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Africa is blessed with great diversity of plant resources that play major role in the continent's food, socio-economic and cultural development. These traditional leafy vegetables help to improve the nutritional status of populations and generate significant income in both rural and urban areas. Hence, this study investigated the nutrient contents and level of heavy metals in *Corchorus olitorius* collected from dumpsite (Okofili in Alimosho Local Government Area) and farmland (Post Service in Ojo Local Government Area) using a standard procedure and t-test analysis. The results showed the presence of amino acids (aspartic acid, glutamic acid, serine, glycine, histidine, Arginine, threonine, alanine, proline, tyrosine, valine, methionine, cysteine, iso-leucine, leucine, phenylalanine and lysine) in *C. olitorius* from both sites, however no significant ($p > 0.05$) difference exists between the mean of all the amino acids taken from both sites. Values of metals recorded in dumpsites were higher than that from farmland. However, only calcium (Ca), iron (Fe), potassium (K), magnesium (Mg), sodium (Na), phosphorus (P), and zinc (Zn) had higher significant differences in values for both the soil and *C. olitorius*. The respective values of these metals

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(mg/100g) in *C. olitorius* at dumpsite and farmland are: Ca (985.3±310.8, 633.8±190.1), Fe (141.4±18.314, 5.415±0.742), K (112.200±51.477, 32.200±13.717), Mg (308.050±121.552, 107.050±3.889), Na(37.995±16.497, 25.015±5.550), P(305.635±257.860, 137.500±39.739) and Zn(18.235±13.103, 4.380±1.810). Potassium/sodium ratio (K/Na) for *C. olitorius* at both sites is comparable to recommended value of 1.00. In conclusion, all the values of metals (except Na in soil and K in plant) are within WHO/FAO maximum recommended limits. Therefore, *C. olitorius* examined in this study is safe for consumption while the metals in both farmland and dumpsite are considered to be less concentrated.

Keywords: Nutritional value; heavy metal; *C. olitorius*; amino acid; dumpsite; farmland.

1. INTRODUCTION

Africa is endowed with great diversity of plant resources that play a major role in the continent's food, socio-economic and cultural development [1]. Among these plant resources are the traditional or indigenous leafy vegetables whose leaves are eaten raw or cooked [2]. These traditional leafy vegetables help to improve the nutritional status of populations and generate significant income in both rural and urban areas [3]. Various studies have shown the nutritional value of leafy vegetables by determining the levels of protein, lipids, fiber, ash, vitamin C, minerals, and vitamin A [4,5]. In addition to providing essential nutrients, leafy vegetables are involved in the protection of human body against a number of metabolic, physiological and free radical damage [6,7]. aimed that for a better exploitation of leafy vegetables such as *Corchorus olitorius*, *Abelmoschus esculentus*, *Vigna unguiculata*, *Ipomea batatas*, *Solanum melongena* etc, it is necessary to evaluate their amino acid and fatty acid contents. Studies have shown that leaves of *C. olitorius* are very rich in proteins, β -carotene, iron, calcium, vitamin B, folic acid, amino acid and essential minerals [8] Its leaves are used as herbal pharmacopoeia against malaria or typhoid fever. They are also rich in vitamins (A, C, E) [9] Its stem is an important source of fiber for making clothing, bags, ropes, and packaging while its fruit and seeds can be used as tonic and diuretic [10].

However, the contamination of vegetables with heavy metals due to soil and atmospheric pollution poses a threat to its quality and safety [10]. Elaigwe et al. [11] reported that crops and vegetables grown in soils are more contaminated with heavy metals accumulation than those grown in uncontaminated soils. Various studies have shown that dumpsite soils in south-western Nigeria and other parts of the country support plant growth and biodiversity and as such they have been extensively used for

cultivating varieties of edible vegetables and plant based foodstuffs [12] These practices pose serious health and environmental concerns due to the anthropogenic contaminations of these waste soils with intolerable levels of chemical substances [13]. Hence, there is a need to evaluate the chemical forms or species of these heavy metals which control bioavailability or mobility and which ultimately control heavy metal soil-plant transfer [14,15]. It is against this background that the present study aimed to investigate the concentration of heavy metals (Fe,Ca As,Co, Cd,K, Na,P,Se,Mg Cr, Cu, Pb, Mn, Ni and Zn) in *Corchorus olitorius* and soil samples from a dumpsite (at Okofili in Alimosho Local Government) and farmlands (at Post Service in Ojo Local Government). The nutrient and amino acids profiles of the plant across the two sampling sites.

2. MATERIALS AND METHOD

2.1 The practice of Collection and Safeguarding Samples from the Study Site

Samples of *Corchorus olitorius* used for this study were collected from Okofili (dumpsite) at Alimosho Local Government Area, and Post Service (Farmland) at Ojo Local Government Area of Lagos, Nigeria between October and December, 2020. The plant species (*C. olitorius*) from each sampling sites were uprooted, while the soil particles were removed from the roots. The plants were kept in a paper bag, tied and labelled with a masking tape and a marker. The soil and plant samples were taken to the laboratory for heavy metal, nutrients and amino acids analysis.

2.2 Sample Extraction

5g each of the samples was weighed into a porcelain crucible and ashed in a muffle furnace

at 550°C FOR 4hs. Thereafter the residue was allowed to cool, and then dissolved with 5ml of dilute nitric acid. The mixture was diluted to 25ml with distilled water and the solution filtered through whatman filter paper. The filtrate was saved for the determination of metals.

2.3 Digestion and Measurement of Heavy Metals (Cu,Cr,Cb,Pb)

Heavy metals, Cu, Zn, Cr, Mn, Co, and Pb were determined using atomic absorption spectrophotometer. The Ca, Mg, Fe Na and K contents of the sample were determined using atomic emission spectrometer and phosphorus by colorimetric method [16].

2.4 Amino Acids analysis

A set of amino acid standards (Merck Germany) were used to calibrate the HPLC (High performance liquid chromatography) while identification of the amino acids in the samples was carried out by comparison with the retention times of the standards.

Aliquots of 20 µL of standard solution, containing 0.20 mg/ml of each amino acid in 0.1 M HCl, were used for calibration. Similarly, 20 µL of the sample extracts were diluted with 180 µL of the reaction buffer (0.15 M sodium hydrogen carbonate, pH 8.6 with NaOH), and then mixed by vortex,-, The resulting solutions were incubated at 70°C in a water bath for 15 min. The reaction was stopped by placing the vials in an ice bath for 5 min. A total of 400 µL of the dilution buffer [mixture of 50 ml of acetonitrile, 25 ml of ethanol, and 25 ml of 9 mM sodium dihydrogen phosphate; 4% dimethylformamide; and 0.15% triethylamine (pH 6.55 with phosphoric acid)] was added, followed by thorough mixing and centrifugation (5 min, 5000 rpm). 20 µL of the clear supernatants were then injected into the HPLC. Dabsyl derivatives of free amino acids were separated on an Agilent 1100 HPLC system, using a reversed-phase Spherisorb ODS 2 column (25.0 cm × 0.46 cm; 5 µm particle size).

Detection was achieved with a UV detector set at 254 nm. Free amino acid quantification was accomplished by the absorbance recorded in the chromatograms relative to external standards. Under the assay conditions described, a linear relationship between the concentration of amino acids and the absorbance at 254 nm was

obtained in the tested range. The results were expressed as mean values and standard error, for the two sampling sites (farmland and dumpsite). The compound identification was based on the comparison between the retention time of the standards of the amino acids and those in the samples. Quantitation was based on the external standard method using calibration curves fitted by linear regression analysis Data were acquired and processed using Agilent Chemstation software.

2.5 Statistical Analysis

The data on the plant and soil samples from both dumpsites and farmland were computed using Statistical Package for Social Science (SPSS, Version 20) while the mean concentration of heavy metals, nutrients and amino acids at both sites were analyzed using t-test and the level of significance at 95% confidence was set at $p \leq 0.05$.

3. RESULTS

3.1 Concentrations of Amino Acids in *Corchorus olitorius* from Dumpsite and Farmland

The summary of the mean concentrations (g/100 g) of amino acids in *Corchorus olitorius* obtained from Oko fili dumpsite and farmland in Ojo, Lagos is presented in Table 1.

There was no significant ($p > 0.05$) difference between the mean concentrations of all the amino acids (aspartic acid, glutamic acid, serine, glycine, histidine, arginine, threonine, alanine, proline, tyrosine, valine, methionine, cysteine, iso-leucine, leucine, phenylalanine and lysine) examined across the two sampling stations.

However, the frequency distribution of the amino acids (Fig. 1) showed that the least abundant amino acid in the plant from both sites was aspartic acid, while the most abundant amino acids from the farmland and dumpsites respectively was glutamic acids.

3.2 Heavy Metal Concentration in the soil and *Corchorus olitorius*

Table 2 presented the heavy metals concentration in soil and *Corchorus olitorius* grown on a dumpsite and farmland in Lagos state, Nigeria.

Table 1. Amino acid contents in *Corchorus olitorius* from dumpsite and farmland in Lagos, Nigeria

Amino acids (g/100g)	Dumpsite	Farmland
Aspartic Acid (Asp)	0.083±0.027 ^a	0.141±0.066 ^a
Glutamic Acid (Glu)	1.312±0.520 ^a	2.050±0.255 ^a
Serine (Ser)	0.597±0.103 ^a	0.631±0.058 ^a
Glycine (Gly)	0.872±0.139 ^a	1.069±0.069 ^a
Histidine (His)	0.361±0.083 ^a	0.334±0.066 ^a
Argenine (Arg)	0.912±0.096 ^a	0.982±0.083 ^a
Threonine (Thr)	0.916±0.147 ^a	0.856±0.176 ^a
Alanine (Ala)	1.097±0.023 ^a	0.977±0.079 ^a
Proline (Pro)	1.097±0.287 ^a	1.200±0.042 ^a
Tyrosine (Tyr)	0.456±0.218 ^a	0.539±0.059 ^a
Valine (Val)	1.116±0.275 ^a	1.132±0.124 ^a
Methionine (Met)	0.652±0.153 ^a	0.943±0.095 ^a
Cysteine (Cys)	0.717±0.054 ^a	0.877±0.095 ^a
Iso-Leucine (Ile)	0.525±0.332 ^a	0.630±0.296 ^a
Leucine (Leu)	1.275±0.629 ^a	1.179±0.694 ^a
Phenylalanine (Phe)	1.108±0.470 ^a	1.237±0.175 ^a
Lysine (Lys)	0.829±0.453 ^a	1.097±0.161 ^a

Mean±SD with same superscript in the row = no significant difference ($p>0.05$)

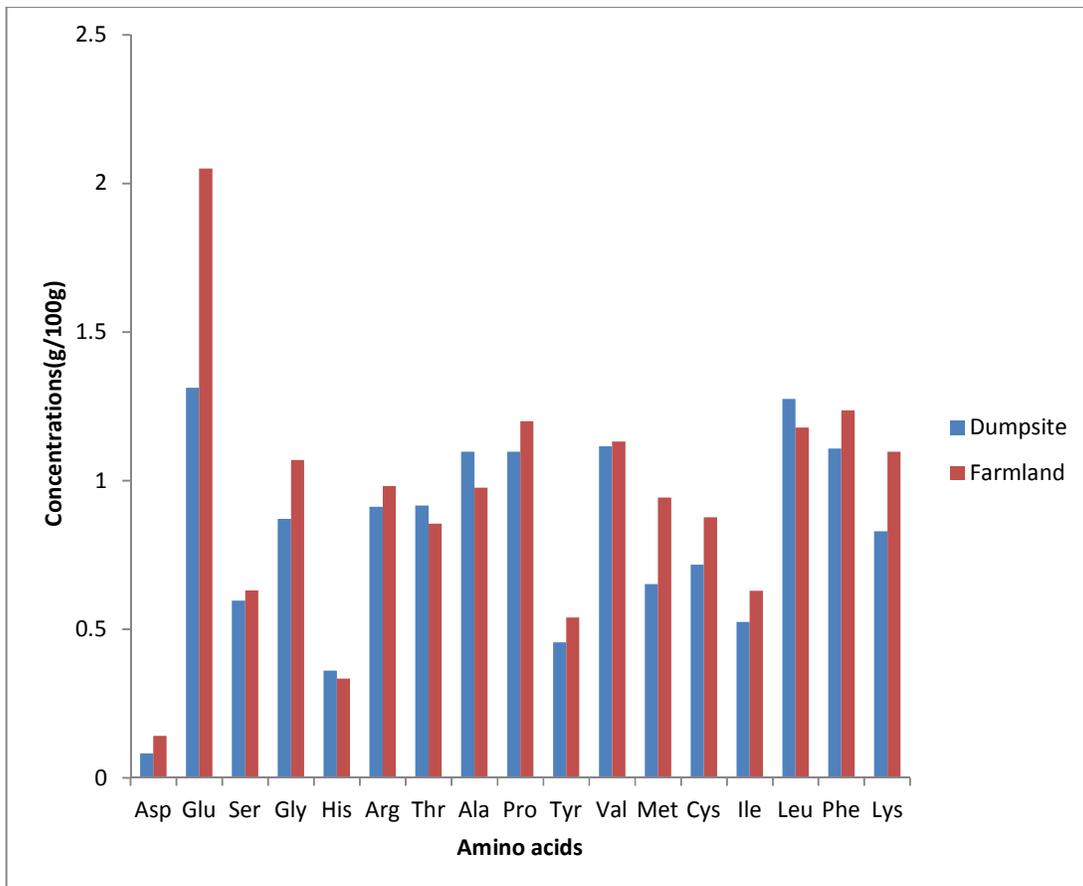


Fig. 1. Frequency distribution of amino acid in *Corchorus olitorius* from dumpsite and farmland in Lagos, Nigeria

Table 2. Heavy Metal Content in *Corchorus olitorius* and soil from dumpsite and farmland in Lagos, Nigeria

Heavy Metals (mg/100g)	Dumpsite		Farmland	
	<i>C. olitorius</i>	Soil	<i>C. olitorius</i>	Soil
Arsenic	0.036±0.048 ^a	0.011±0.004 ^a	ND	ND
Calcium	985.250±310.773 ^a	249.300±15.415 ^b	633.750±190.141 ^{aa}	221.650±48.295 ^{bb}
Cobalt	0.015±0.008 ^a	0.012±0.001 ^a	0.002±0.001 ^a	0.009±0.002 ^a
Chromium	0.205±0.021 ^a	0.109±0.017 ^a	0.070±0.042 ^a	0.030±0.020 ^a
Copper	0.615±0.078 ^a	1.800±1.640 ^a	0.140±0.042 ^a	0.400±0.310 ^a
Iron	141.350±18.314 ^a	331.180±280.62 ^b	5.415±0.742 ^{aa}	77.000±40.305 ^{bb}
Potassium	112.200±51.477 ^a	225.800±133.926 ^b	32.200±13.717 ^{aa}	193.900±119.642 ^{bb}
Magnesium	308.050±121.552 ^a	820.050±308.228 ^b	107.050±3.889 ^{aa}	717.800±244.518 ^{bb}
Nickel	0.850±0.810 ^a	ND	0.020±0.014 ^a	ND
Sodium	37.995±16.497 ^a	3863.500±2336.988 ^b	25.015±5.550 ^{aa}	3032.400±2742.584 ^{bb}
Phosphorus	305.635±257.860 ^a	500.350±126.077 ^b	137.500±39.739 ^{aa}	310.900±123.885 ^{bb}
Lead	0.040±0.030 ^a	0.078±0.045 ^a	0.007±0.005 ^a	0.004±0.001 ^a
Selenium	0.002±0.001 ^a	0.015±0.001 ^a	0.001±0.001 ^a	ND
Zinc	18.235±13.103 ^a	21.815±18.080 ^b	4.380±1.810 ^{aa}	6.100±0.156 ^{bb}
Manganese	3.790±0.594 ^a	3.085±1.279 ^a	1.660±0.000 ^{aa}	1.970±0.169 ^a

Mean ±SD with different superscript in the row = significant difference ($p < 0.05$). ND= not detected

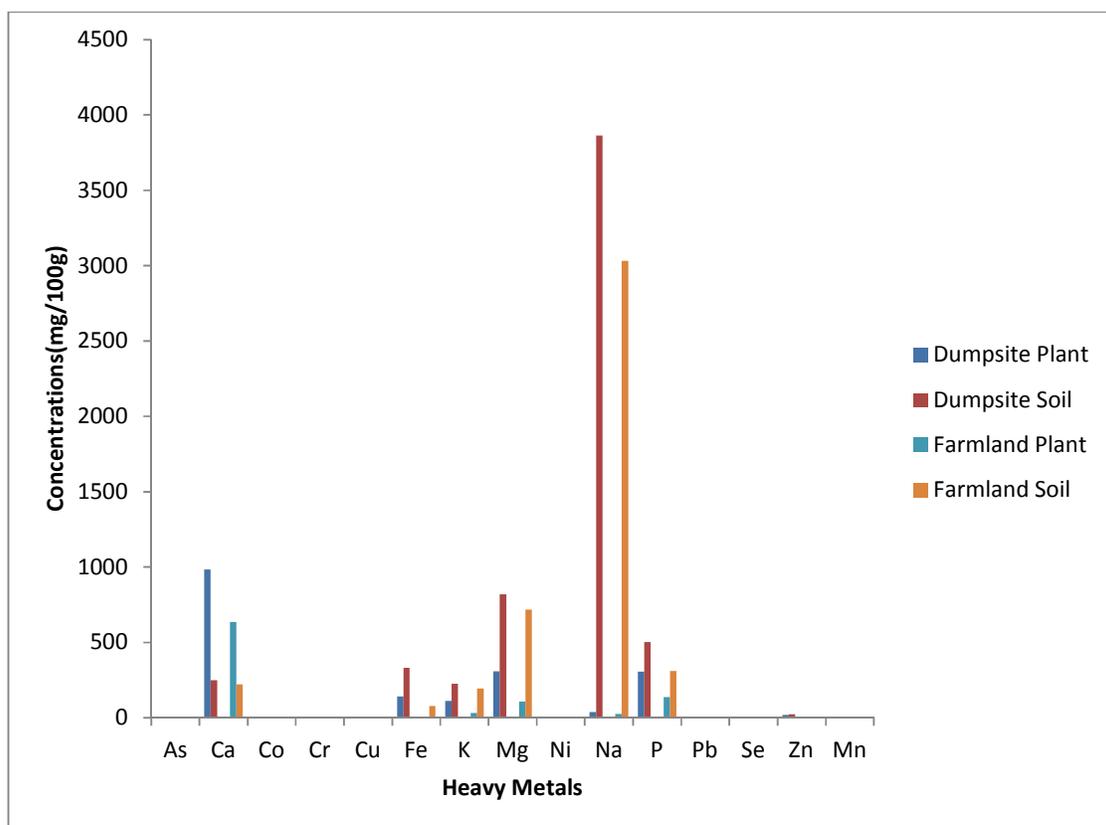


Fig. 2. Frequency distribution of heavy metals in *Corchorus olitorius* from dumpsite and farmland in Lagos, Nigeria

The results showed that calcium (Ca), iron (Fe), potassium (K), magnesium (Mg), sodium (Na), phosphorus (P), and zinc (Zn) had higher significant mean values in *C. olitorius* in soil which was in favour of the dumpsite as against that of farmland. The respective values of these metals (mg/100g) in *C. olitorius* at dumpsite and farmland were: Ca (985.250±310.773, 633.750±190.141), Fe (141.4±18.3, 5.415±0.742), K (112.2±51.477, 32.200±13.717), Mg (308.1±121.6, 107.1±3.889), Na (37.995±16.497, 25.015±5.550), P (305.6±257.9, 137.5±39.739) and Zn (18.235±13.103, 4.380±1.810). On the other hand, values of Calcium (249.3±15.415, 221.7±48.295), iron (331.2±280.6, 77.000±40.305), potassium (225.8±133.9, 193.9±119.6), magnesium (820.050±308.228, 717.800±244.518), sodium (3863.5±2337.0, 3032.4±2742.6), phosphorus (500.4±126.077, 310.9±123.9) and zinc (21.815±18.080, 6.100±0.156) were recorded in the soil from dumpsite and farmland respectively. However, there are no significant difference ($p>0.05$) between lead (Pb), cobalt (Co), copper

(Cu), chromium (Cr) and selenium (Se) across the two sampling sites, while arsenic was not detected in farmland samples. Also, nickel was not detected in the soil samples from both farmland and dumpsite. Fig. 2 shows the frequency distribution of the metals in soil and *C. olitorius* from both the dumpsite and farmland.

The metal with the highest concentration in plant and soil from the dumpsite are calcium and sodium respectively, while the respective least abundant metals in soil and plant from the dumpsite are arsenic and selenium. On the other hand, at the farmland, most least frequent metal in the plant are calcium and selenium respectively, while the most frequent and least metal in the farmland soil are sodium and lead respectively.

4. DISCUSSION

There was no significant difference between the mean concentrations of all 17 amino acids recorded in this study. The least abundant amino acid in the plant from both sites was aspartic

acid, while the most abundant amino acids from the farmland and dumpsites respectively was glutamic acids. In contrast to the observation in this study as regards most abundant amino acid in *C. olitorius*, out of the seven essential amino acids (phenylalanine, leucine, threonine, valine, lysine, methionine and tyrosine) examined by Otchoumou et al. [3] in *C. olitorius* and *Vigna unguiculata*, leucine was the most abundant in leafy vegetables. The leucine abundance in leafy vegetables may explain their use in traditional medicine, particularly for the healing of skin infections [17]. However, all the values of amino acid recorded in the present study are lower than that reported by Otchoumou et al. [3].

The heavy metals concentration in soil and *C. olitorius* grown on a dumpsite and farmland as presented in Table 2 showed that only calcium, iron, potassium, magnesium, sodium, phosphorus, and zinc had higher significant differences in values for both the soil and *C. olitorius* in favour of the dumpsite as against that of farmland. Similar results have been reported in soil and *C. olitorius* from both abandoned dumpsites and farmlands in Isolo [18]. However, Pb, Cu, and Cr contents reported in the soil and *C. olitorius* by Oyelola et al. [18], exceeded those obtained in this study. The findings of Sanyaolu et al. [19] particularly on the mean concentration of Pb Cd and Zn in *C. olitorius* leaves at highway favourably compare with the present findings.

Elaigwe et al. [11] who carried out research on the bio-monitoring of vegetables reported that farming in dumpsites has a negative impact on human health due to high concentration of trace metals in plants from the environment which subsequently enters the food chain. Similarly, Kikelomo et al. [20] reported the damaging effects of heavy metals especially Cd on sperm quality and formation while Adeleken and Abegunde [21] noted that heavy metals have low environmental mobility and as a result of this, a single contamination could set a stage for a long term exposure of heavy metals to human, microbial, fauna, flora and other edaphic communities.

The findings of Osakwe and Otuya [22] on the chemical fractionation, mobility and bioavailability of Cd, Cu, Mn, Pb and Zn in refuse waste soils of some dumpsites in Zaria metropolis, were higher than that in the present study. Moreso, findings of Obasi et al. [23] on heavy metals (Cd, Cu, Mn, Pb, Zn, Fe, Ni and Cr) in refuse waste soils of some dumpsites along Enugu-Port Harcourt

expressways, South-East, Nigeria revealed that metals in the dumpsites were significantly higher than that from the farmland. This was in agreement with the results in the present study.

In this study, the metal with the highest concentration in *C. olitorius* from the dumpsite and farmland was calcium. However, Oloye et al. [24] which worked on the mineral content of the deffated raw wild *C. olitorius* indicated that the most abundant of the minerals studied was magnesium, followed by potassium, calcium, sodium and phosphorus while the least were iron and manganese.

The potassium/sodium ratio (K/Na) reported by Oloye et al. [24] was greater than that obtained in this study, however, the present ratio is comparable to recommended WHO value of 1.00. High amount of Ca, K and Mg in diets have been reported to reduce blood pressure. Calcium is responsible for teeth and bone formation in conjunction with phosphorus, magnesium, manganese, choline, vitamins A, C, D, and protein in general. For this study, higher significant values of Ca, Fe, K, Mg, Na, P, and Zn were obtained in soil from dumpsite in comparison to soil from farmland. Similarly, Obasi et al. [23] had reported higher metals in dumpsite's soil along Enugu-Port Harcourt expressways in comparison to soil from farmland. The values of metals in the soil for this study were lower than that reported in soil from dumpsite and farmland at Isolo (Oyelola et al. [18]) In like manner, the findings of Osakwe and Otuya [22] on waste soils of some dumpsites in Zaria metropolis, were higher than what was obtained in the present study. However, the metals in the soil for this study were still within the standard permissible limits. Adeleken and Abegunde [21] have noted that heavy metals have low environmental mobility and as a result of this, a single contamination could set a stage for a long term exposure of heavy metals to human, microbial, fauna, flora and other edaphic communities. Okoronkwo et al. [25] reported that sand, organic matter and cation exchange capacity (CEC) significantly and positively correlated with Cr and Pb, and thus indicated that these factors largely control the concentration of these elements in the soils.

Like every living organism, vegetables are often sensitive both to the deficiency and to the excess availability of some heavy metal elements as essential micronutrient, while the same at higher concentrations and even more ions such as Cd

and Hg are strongly poisonous to the metabolic activities. However, all the values of metals (except Na in soil and K in plant) in this study were found to be within the WHO/FAO [26,27] maximum recommended limits. The low concentration of metals like lead (Pb), cobalt (Cb), copper (Cu), chromium (Cr) and selenium (Se) in the plant and soil samples across the two sampling sites also affirmed that the two sites are less polluted and thus the plants are safe for consumption.

5. CONCLUSION

Seventeen (17) amino acids were detected in *C. olitorius* at both sampling sites. The least abundant amino acid in the plant from both sites was aspartic acid, while the most abundant amino acids from the farmland and dumpsites respectively was glutamic acids. Among the metals concentration recorded in soil and *C. olitorius* grown on a dumpsite and farmland, only Ca, Fe, K, Mg, Na, P, and Zn had higher significant differences in values for both the soil and *C. olitorius* in favour of the dumpsite as against that of farmland. The metal with the highest concentration in *C. olitorius* from the dumpsite and farmland was calcium while the ratio (K/Na) is comparable to recommended value of 1.00. Values of metals like lead, cobalt, copper, chromium and selenium in the plant and soil samples across the two sampling sites are very low. Also, all the values of metals (except Na in soil and K in plant) are within WHO/FAO maximum recommended limits. It could therefore be concluded that *C. olitorius* is safe for consumption because the two sites are considered to be within the permissible heavy metal concentration.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Akinnifesi FK, Kwesiga F, Mhango J, Chilanga T, Mkonda A, Kadu CAC, Kadzere I, Mithofer D, Saka JDK, Sileshi G, Ramadhani T. Towards the Development of Miombo Fruit Trees as Commercial Tree Crops in Southern Africa. *Forests, Trees and Livelihoods*. 2006;16 (1):103-121.
2. FAO. *Traditional Food Plants*. Food and Nutrition Paper. FAO, Ed., Rome, Italy. 1998;42:1-3
3. Otchoumou KA, Wognin LMFR, Zoué LYT, Yao KF, Niamké S. Amino Acids and Fatty Acids Composition of *Abelmoschus esculentus*, *Vigna unguiculata*, *Corchorus olitorius*, *Ipomea batatas*, *Solanum melongena* Sold on the Syporex Market of Yopougon (Cote D'ivoire). *International Journal of Research – Granthaalayah*. 2018;6(11):315-322.
4. Zoro AF, Zoué LT, Kra SAK, Yépié AE, Niamké MSL. An Overview of Nutritive Potential of Leafy Vegetables Consumed in Western Côte D'ivoire. *Pakistan Journal of Nutrition*. 2013;12 (10):949-956.
5. Acho CF, Zoué LT, Akpa EE, Yapo VG, Niamké SL. Leafy Vegetables Consumed in Southern Côte D'ivoire: A Source of High Value Nutrients. *Journal of Animal and Plant Sciences*. 2014;20 (3):3159-3170.
6. Aletor MV, Adeogun OA. Nutrient and Antinutrient Components of Some Tropical Leafy Vegetables. *Food Chemistry*. 1995; 53:375-379.
7. Mavengahama S, Mc Lachlan M, de Clercq W. The role of wild vegetable species in household food security in maize based subsistence cropping systems. *Food Security*. 2013;5:227-233
8. Dansi A, Adjatin A, Adoukonou-Sagbadja H, Faladé V, Yedomonhan H, Odou D. and Dossou B. Traditional leafy vegetables and their use in the Benin Republic. *Genetic Resources and Crop Evolution*. 2008;55: 1239-1256.
9. Zakaria ZA, Somchit MN, Zaiton H, Mat-Jais AM, Suleiman MR, Farah W, Nazaratul-Marawana R, Fatimah CA. The in vitro antibacterial activity of *Corchorus olitorius* extracts. *International Journal of Pharmacology*. 2006;2:213-215.
10. Yusuf KA, Osibanjo O. Nutritional potential of some tropical vegetables leaf meals, chemical characterization and functional

- properties. African Journal of Biotechnology. 2006;5(1):49-53.
11. Elaigwe SE, Ajibola VO, Folaranmi FM. Studies on the impact of municipal waste dump on surrounding soil and air quality of two cities in northern Nigeria. Journal of Applied Sciences. 2007; 7(3):421-425.
 12. Benson NU, Ebong GA. Heavy metals in vegetables commonly grown in a tropical garden ultisol, Journal of Sustainable Tropical Agricultural Resources. 2005; 16:77-80.
 13. Jarup L. Hazards of heavy metals contamination. British Medical Bulletin. 2003;68:167-182.
 14. Uba S, Uzairu A, Harrison GFS, Balarabe ML, Okunola OJ. Assessment of heavy metals bioavailability in dumpsites of Zaira metropolis, Nigeria. African Journal of Biotechnology. 2008;7:122-130.
 15. Ikhouria EU, Urunmatsoma SOP, Okieimen FE. Preliminary investigation of chemical fraction and heavy metal accumulation in plant maize (*Zea mays*) grown on chromated copper arsenate (CCA) contaminated soil amended with poultry droppings, African Journal of Biotechnology. 2010;9:2675- 2682.
 16. AOAC. Approved methods of the (AOAC 1990); 8th ed. St-Paul, MN.
 17. Vaishali SK, Varsha DJ. Traditional Leafy Vegetables: A Future Herbal Medicine. International Journal of Agricultural and Food Science. 2013;3 (2):56-58
 18. Oyelola OT, Babatunde AI, Odunlade AK. Phytoremediation of metals from contaminated soil using *Lycopersicon esculentum* (Tomato) Plant. International Journal of Pure and Applied Science. 2009;3(2): 44-48.
 19. Sanyaolu VT, Sanyaolu AA, Fadele E. Spatial variation in Heavy Metal residue in *Corchorus olitorius* cultivated along aMajor highway in Ikorodu- Lagos, Nigeria. Journal of Applied Science and Management Science. 2011;15(2):283–287.
 20. Kikelomo FO, Stephen MS, Micheal AF, Udoka EO, Toyin YF. Roles of onions and garlic extracts on cadmium - induced changes in sperm. Journal of Food and Chemical Toxicology. 2008;46: 3604-3611
 21. Adeleken B, Abegunde K. Heavy metal contamination of soil and ground water at automobile mechanic village in Ibadan, Nigeria. International Journal of the Physical Sciences. 2011;6(5):1045-1058.
 22. Osakwe SA, Otuya OB. Elemental composition of soils in some mechanic dumpsites in Agbor, Delta state, Nigeria. Chemical Society of Nigeria. 31st Annual International Conference and Exhibition. Deltachem Conference Proceedings. 2008; 557 - 559.
 23. Obasi NA, Akubugwo EI, Ugbogu OC, Chinyere GC. Heavy metals bioavailability and phyto-accumulation potentials of selected plants on burrow-pit dumpsites; 2012.
 24. Oloye DA, Odej OT, Faboya ET, Ibrahim TA. Proximate and Mineral Composition of Wild *Corchorous olitorius* Seed Flour. Research and Reviews: Journal of Agriculture and Allied sciences. 2013; 3(1):1-4.
 25. Okoronkwo NE, Odemelam SA, Anon OA. Levels of Toxic Elements in soils of abandoned Waste Dumpsites. Journal of Environmental Pollution. 2006;5(13):1241-1244.
 26. FAO. Nutrition Des Pays En Développement. Fao Ed., Rome, Italie. 1996;505 .
 27. World Health Organization (WHO). In: Rattan, R. K., Darts, S. P., Chandra, S., and Saharan, N. (2002): Heavy Metals and Environmental Quality – Indian Scenario, Fertilizer News. 1996;47(11):21-40.

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