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Research Article

Heavy Metal Contents in the Soil and Leaves of Different Vegetables in Lagos State, Nigeria

[1]Fatai Olakunle Ogundele, [2]Anthony Inah Iwara and [3]Chidinma Joy Jeremiah

[1]Department of Geography and Planning, Lagos State University, Lagos State, Lagos, Nigeria
[2]Department of Geography and Environmental Management, University of Abuja, Abuja, Nigeria
[3]Department of Geography, University of Ibadan, Ibadan, Nigeria

Abstract

Background and Objective: Previous studies on edible vegetables considered few vegetables and many did not assess the level of metals under the soil of leafy vegetables. The objective of the study was to assess the concentration of heavy metals in the soil and leaves of 8 vegetables (pumpkin, spinach, lettuce, green onion, curry leaf, scent leaf, water leaf and ewedu) frequently cultivated in Lagos State, Nigeria. **Material and Methods:** Edible leaves of the vegetables and soil samples at depth of 0-15 cm were randomly collected and analyzed for manganese (Mn), iron (Fe), copper (Cu) and zinc (Zn) using Atomic Absorption Spectrophotometer (AAS) technique. **Results:** The concentration of metals in the leaves of the selected vegetable plants showed that Mn, Fe, Cu and Zn had high concentrations in Green onion (0.038 mg kg^{-1}), Pumpkin (0.365 mg kg^{-1}), Pumpkin (0.008 mg kg^{-1}) and Curry and Spinach (0.005 mg kg^{-1}), respectively. The order of metal concentration in the soil was Fe>Mn>Zn>Cu. **Conclusion:** It was concluded that contents of heavy metals in the respective leafy vegetables were safe for consumption as justified by Accumulation Factors (AF) values.

Key words: Heavy metals, leafy vegetable, curry leaf, atomic absorption spectrophotometer, green onion, accumulation factor, edible vegetables, scent leaf

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Corresponding Author: Fatai Olakunle Ogundele, Department of Geography and Planning, Lagos State University, Lagos State, Lagos Nigeria
Tel: +2348033134404

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The ever increasing rate of urbanization in Lagos State has led to the increase and over demand for vegetables[1]. In Ojo area, the concentration has been on the cultivation of vegetables which are highly desirable green leafy crops sold in the urban market and other areas surrounding the cities. As a result of the high and continuous demand, the land area occupied by these vegetable farmers has increased. At the perimeter fence, more land has been converted into vegetable farms with different varieties of vegetables planted both during the wet and dry seasons[2]. Some of the common vegetables of high demand across the state include Pumpkin, Spinach, Lettuce, Green onion, Curry leaf, Scent leaf, Water leaf and Ewedu.

Vegetable, in particular leafy vegetables are the essential part of the human diet and nutrition because they contain some amounts or quantities of amino acid, dietary fibers, carbohydrates, vitamins and minerals[2,3]. These nutrients are necessary to sustain normal performance of human metabolic processes. They are also essential to reduce the effect of acid produced during digestion[3]. In the same manner, it was stated that they are used to augment the quality of soups and are of importance as a result of their nutritional purposes[4]. Despite the nutritional benefits of vegetables, they can also accumulate high proportion of heavy metals and the amount present in the plant varies among the plant parts[5]. For instance, the study of Yargholi *et al.*[6] showed that the roots and leaves of plants contain higher concentration of heavy metal than stems and fruits. This became worrisome as among the commonly cultivated leafy vegetables, the leaves are mostly consumed and forms a larger proportion of household nutrient.

Heavy metal in plant parts are as a result of soil pollution caused by misuse of the soil, such as poor agricultural practices, disposal of industrial and urban wastes[7-10]. A number of metals, such as lead (Pb), iron (Fe), nickel (Ni), chromium (Cr) and copper (Cu) among others can have harmful to plants and humans even at low concentrations[2]. Heavy metal accumulation in soils is of concern in agricultural production due to the adverse effects on food quality, crop growth and environmental health[2]. As a result of the benefits of leafy vegetables to humans, several studies have been carried out to examine the effect of vegetable farming on both soil and vegetable[11] and many other only looked at the effect of metal contents on the vegetable parts[2,12-15]. This is further justified by the fact that previous studies only considered one, two or three of the vegetables and many did not assess the level of metals under the soil of leafy vegetable beds[3,4,16-18]. Many of these studies basically examined the proportion or concentration of metals in the plant parts. The rationale of this study was to further understand metal concentration in leaves of different vegetables and to assess their pollution level. This becomes worrisome considering the fact that the leaves of vegetables are mostly consumed. The objective was to examine heavy metal contents under vegetable soils, assess the contents of heavy metal in vegetable leaves and determine the accumulation factors (AF) of metals in the selected leafy vegetables.

MATERIALS AND METHODS

Study area: The study area is located in Ojo Local Government areas of Lagos state which lies between Latitude 6°42'N and 6°42'N and between Longitude 2°42'E and 3°42'E. The climate is humid with rainfall throughout each month of the year with at least 25 mm of rain falling during the dry season months of January, February and December[19]. Water-logging usually occurs when the water table is less than 2 m from the surface[19]. The cultivation of vegetables in the area helps in meeting the daily demands for green and leafy vegetables in the area and they are major source of household nutrient. These vegetables are cultivated in bed and augmented with organic manure (compost manure).

Collection of samples and analysis: Soil and leafy vegetable leaves were obtained from 24 vegetables beds cultivated with pumpkin (*Talfaria occidentalis*), spinach (*Spinachcia oleracea*), Lettuce (*Lactuca sativa*), Green onion (*Allium fistulosum*), Curry leaf (*Murraya koenigi*), Scent leaf (*Ocimum grattissimum*), Water leaf (*Talimum triangulare*) and Ewedu (*Cochorus olitorus*). All samples were collected around the perimeter fence of LASU main gate with the permission of the farmers. Soil samples and vegetable leaves were randomly from about 300 vegetable beds found in the area. In each selected leafy vegetable bed, soil samples of 0-15 cm were obtained from the centre of the bed using a soil auger, while vegetable leaves were also harvested. The samples were properly stored in polythene bags (soil) and newspapers (leaves), labeled and taken to the laboratory at the University of Ibadan for analysis of Mn, Fe, Cu and Zn using Atomic Absorption Spectrophotometer (AAS) technique. In this study, vegetable leaves were only used because of previous studies Naser *et al*.[2] and Farooq *et al*.[14] have shown that the leaves accumulate higher quantities of heavy metals than other parts (stem, fruits, etc.).

Data analysis: Descriptive statistics and one-way analysis of Variance at 5% significance level were employed to analyze data collected. Statistical analysis and presentation of data were carried out with the aid of SPSS software (version 22; SPSS Inc.; Chicago, IL, USA) and excel spreadsheet. The result obtained for soil and vegetable leaves were further analyzed to examine the Accumulation Factor (AF). This was calculated by dividing the heavy metal concentration in the respective leaves by the heavy metal concentration in the soil. The formula is simply given as:

$$\text{Accumulation factor (AF)} = \frac{\text{Heavy metal concentration in plant leaves (mg kg}^{-1}\text{)}}{\text{Heavy metal concentration in the soil (mg kg}^{-1}\text{)}}$$

Higher values reflected poor retention in soils or greater efficiency of plants to absorb metals, while low values revealed greater efficiency of plants to exclude metals[20]. Accumulation Factors (AF) greater than 1.00 was an indication of hyperaccumulator especially in soils[21], values of 0.1 indicated that plant was excluding metals from its tissues, while the transfer values of 0.2 indicated the chances of metal contamination by anthropogenic activities[20].

RESULTS

Heavy metal contents of soil under vegetables: The result in Table 1 showed that Mn contents varied significantly (F = 303.211, p<0.05) under the soils of the leafy vegetable beds. Mn contents in the studied soils ranged from 113.73-156.33 mg kg^{-1}. The Mn values were within WHO/FAO maximum safe limit of 2000 mg kg^{-1}. The Fe contents ranged from 120.13-210.70 mg kg^{-1}. The contents of Fe varied significantly under the soils of the leafy vegetable beds (F = 14.382, p<0.05). The values of Fe fall within WHO/FAO maximum threshold of 5000 mg kg^{-1}. In addition, the result in Table 1 indicated that Cu varied significantly (F = 221.385, p<0.05); its mean value ranged from 1.21-2.06 mg kg^{-1}. The Cu values fell within WHO/FAO safe limit of 100 mg kg^{-1}. The Zn contents ranged from 9.00-11.07 mg kg^{-1} and its contents varied significantly (F = 8.793, p<0.05). As usual, the Zn values obtained in this study falls within WHO/FAO safe limit of 300 mg kg^{-1}.

Table 1: Heavy metal contents of soil in each vegetable bed

Leafy vegetables	Heavy metal contents[a] Mn (mg kg^{-1})	Fe (mg kg^{-1})	Cu (mg kg^{-1})	Zn (mg kg^{-1})
Pumpkin	115.20±1.45	185.93±3.02	1.41±0.01	10.20±0.10
Ewedu	134.67±0.88	177.00±1.15	1.50±0.06	9.00±0.50
Curry	121.87±0.93	201.33±0.73	2.02±0.01	9.27±0.63
Scent	113.73±1.87	210.70±0.35	2.02±0.00	10.33±0.17
Lettuce	117.33±0.17	133.50±1.76	1.21±0.00	10.97±0.03
Spinach	156.33±0.18	150.03±0.03	2.00±0.00	11.07±0.03
Green onion	123.67±0.33	120.13±0.13	2.06±0.03	9.77±0.03
Water leaf	99.87±0.03	181.33±0.17	2.09±0.00	8.53±0.27
F-ratio	303.211*	14.382*	221.385*	8.793*

[a]Values are means±standard errors, *Significant at 5% alpha level, df: 7/16

Table 2: Heavy metal contents in vegetable leaves

Leafy vegetables	Contents of heavy metal in vegetable leaves[a] Mn (mg kg^{-1})	Fe (mg kg^{-1})	Cu (mg kg^{-1})	Zn (mg kg^{-1})
WHO/FAO limits	40	48	40	60
Pumpkin	0.027±0.000	0.365±0.000	0.008±0.006	0.004±0.000
Ewedu	0.018±0.000	0.123±0.001	0.003±0.000	0.003±0.000
Curry	0.027±0.001	0.233±0.000	0.002±0.001	0.005±0.001
Scent	0.016±0.001	0.225±0.001	0.002±0.000	0.004±0.001
Lettuce	0.024±0.001	0.233±0.001	0.002±0.001	0.004±0.001
Spinach	0.019±0.001	0.274±0.001	0.002±0.000	0.005±0.001
Green onion	0.038±0.026	0.218±0.001	0.003±0.001	0.004±0.001
Water leaf	0.013±0.001	0.111±0.001	0.001±0.000	0.002±0.001
F-ratio	0.771[#]	10400.581*	0.956[#]	2.675*

[a]Values are means±standard errors, *Significant at 5% alpha level, df: 7/16, [#]Insignificant at 5% alpha level

Contents of heavy metal in vegetable leaves: The contents of metal in the respective vegetable leaves in Table 2 showed that Mn proportion ranged from 0.013-0.038 mg kg^{-1}. Mn contents fell within WHO/FAO threshold of 40 mg kg^{-1}. Mn content in the vegetable leaves did not vary significantly (F = 0.771, p>0.05). The mean content of Fe ranged from 0.111-0.365 mg kg^{-1} and it varied significantly among the vegetable leaves (F = 10400.581, p<0.05). Fe content was within WHO/FAO limit of 48 mg kg^{-1}. Furthermore, the content of Cu and Zn ranged from 0.001-0.008 mg kg^{-1} and 0.002-0.005 mg kg^{-1}, respectively. The Cu and Zn contents fell within WHO/FAO threshold of 40 and 60 mg kg^{-1}, respectively. Cu content did not vary significantly among the vegetable leaves (F = 0.956, p>0.05), while the content of Zn varied significantly (F = 2.675, p<0.05). The same order of metal concentration under the soil of leafy vegetables was also reported for the vegetable leaves: Fe>Mn>Zn>Cu. This order suggests that Fe and Mn are dominant metals in the vegetable leaves, while Cu has the lowest content.

Accumulation Factors (AF): The Accumulation Factors (AF) showed very low concentration with values

Table 3: Mean accumulation factor of heavy metal contents in vegetable leaves (mg kg^{-1})

	Accumulation factor[a]				
Leafy vegetables	Mn (mg kg^{-1})	Fe (mg kg^{-1})	Cu (mg kg^{-1})	Zn (mg kg^{-1})	Total AF
Pumpkin	0.00024	0.00196	0.00544	0.00036	0.008
Ewedu	0.00013	0.00069	0.00177	0.00030	0.00289
Curry	0.00023	0.00116	0.00099	0.00054	0.00292
Scent	0.00014	0.00107	0.00083	0.00039	0.00243
Lettuce	0.00020	0.00175	0.00166	0.00036	0.00397
Spinach	0.00012	0.00183	0.00100	0.00045	0.0034
Green onion	0.00031	0.00181	0.00147	0.00041	0.004
Water leaf	0.00013	0.00061	0.00064	0.00024	0.00162
F-ratio	0.854[#]	1103.780*	1.139[#]	2.213[#]	0.02923

*Significant at 5% alpha level, df: 7/16, [#]Insignificant at 5% alpha level

ranging from 0.00013-0.00544 (Table 3). The AF of Mn in the leaves of the sampled vegetable leaves ranged from 0.00012-0.00031 mg kg^{-1}; AF of Fe ranged from 0.0006-0.00196 mg kg^{-1}; Cu ranged from 0.00064-0.00544 and Zn ranged from 0.00024-0.00054 mg kg^{-1}. There was a significant variation in Fe accumulation in the vegetable leaves ($F = 1103.68$, $p<0.05$), while there were no significant variations in the accumulation of Mn, Cu and Zn ($p>0.05$).

DISCUSSION

The results obtained clearly showed that soils under the vegetable beds had varying quantities of heavy metals. It goes to show that the soils are polluted with metals. This is expected considering the location where vegetable farming is practiced. The location of the site close to the road makes it prone to metal pollution from vehicular movement and other anthropogenic activities within the catchment area. Metal contents in the soil fell within WHO/FAO safe limit[22] of 300 mg kg^{-1}. The dust along the road when blown into the adjoining vegetable beds results in metal accumulation. Metal pollution in the soil is acknowledged in the literature to result from industrial and vehicular emissions, mechanic wastes, wastewater irrigation and the application of pesticides and fertilizers on agricultural lands[23]. In this study, the high Mn may be attributed to wastewater from different land uses in the area that accumulate in the surface soil during floods. Similar reason was studied in another research. The Fe content under the soils of the sampled vegetables was far below the values reported[22]. The concentrations of Cd, Cu, Zn and Pb in surface soils are suggested by scholars to be greatly influenced by lead-acid batteries and motor vehicles among others[24,25]. The contents of Cu and Zn were consistent with earlier reported by Chiroma *et al*.[22].

The high content of metals in soils under the vegetable beds was attributed to anthropogenic activities such as emissions from vehicular traffic and wastewater from industrial and residential areas within the catchment of the vegetable gardens. This is consistent with the studies of Adu *et al*.[3], Jarup[7], Qin *et al*.[8] and Zhang *et al*.[9] that attributed the concentration of heavy metal in the soil to biological and geochemical cycles as well as anthropogenic activities such as agricultural practices, industrial activities and waste disposal methods. The poor access to land in Lagos has made farmer to cultivate these vegetables along road edge, dumpsites and other unsafe places that may be vulnerable to heavy metal pollution. The cultivation of vegetables along road verges can result in metal pollution which would accumulate in the soil and vegetable parts[3,17,26].

The content of Mn in the vegetable leaves was within the values reported by Olowu *et al*.[27]. Fe proportion in the selected vegetable leaves also fell within the values reported by Doherty *et al*.[26], but far below the mean values reported by Adu *et al*.[3]. Also, the content of Cu and Zn reported in the present study was within the values reported by Adu *et al*.[3] and Olowu *et al*.[27], but below the values reported by Doherty *et al*.[26] for some leafy vegetables in Lagos State. The order of metal concentration in the vegetable leaves simply showed that Fe and Mn were foremost metals in vegetable leaves, while Cu was the least metal under. However, the result obtained on the concentration of heavy metals in the vegetable leaves generally shows low concentration of metals in the selected leafy vegetables. The values reported in this study happen to be lower compared to the values reported by previous studies[3,26,27]. The low concentration of heavy metals in the selected leafy vegetables collected around LASU perimeter gate and sold to millions of people across Lagos State and its neighbouring states showed they were of good quality and safe for consumption. Similar low metal concentration of metal in selected leafy vegetable was reported by Doherty *et al*.[26] and Yusuf and Oluwole[28] in Lagos State.

The AF results indicated that among the heavy metals studied, Fe was most variable. The order of AF showed the possibility of the plants to buildup copper. The Cu is an essential metal required for regular biological activities of amino-oxides and tyrosinase enzymes. The AF values obtained for the respective vegetable leaves were indication of low accumulation of metals in the leaves of the vegetables. Similar result in Lagos state, Nigeria was early reported by Adesuyi *et al.*[29]. This simply showed strong sorption of metal to the soil colloids[20], which further meant that the leafy vegetables were excluding the metals from their tissues. In addition, the accumulation factors (AF) being less than 1.00 was a sign of low hyperaccumulation in plants. However, irrespective of the generally low AF in the sampled vegetable leaves, there is need for regular environmental monitoring to control metal pollution in vegetable gardens. The AF result obtained in the present study is consistent with the previous finding[29], when they reported low transfer factors of less than 1 for most of the plants species.

CONCLUSION

The results had shown that the contents of heavy metals in the respective leafy vegetables were below WHO/FAO safe limits implying they were of good quality and safe for consumption. The accumulation factor further justified the safety of the vegetables for consumption. The low presence of metals in the vegetable leaves was not however, an assurance of the leafy vegetables. Based on the findings, it is recommended that regular monitoring to control metal pollution and to safeguard the health of millions consumers should be carried out. There was the need to educate and encourage farmers to avoid using and cultivating close to wastewater and highways. Future studies should examine the extent of metal pollution as well as sources of pollution in plant parts and soil at different locations.

SIGNIFICANCE STATEMENT

This study has discovered that heavy metal contents in the leaves of vegetables are within the safe limits for human consumption in spite of their locations (close to road verges). This study has also shown the existence of varied amount of heavy metal concentration in different leafy vegetables which earlier studies and researchers were not able to explore.

REFERENCES

1. Ukpong, I.E. and J.O. Moses, 2001. Nutrient requirements for the growth of waterleaf (*Talinum triangulare*) in Uyo metropolis, Nigeria. Environmentalist, 21: 153-159.
2. Naser, H.M., S. Sultana, N.U. Mahmud, R. Gomes and S. Noor, 2011. Heavy metal levels in vegetables with growth stage and plant species variations. Bangladesh J. Agric. Res., 36: 563-574.
3. Adu, A.A., O.J. Aderinola and V. Kusemiju, 2014. Assessment of trace metal levels in commonly edible vegetables from selected markets in Lagos state, Nigeria. Curr. World Environ., 9: 789-796.
4. Sobukola, O.P., O.M. Adeniran, A.A. Odedairo and O.E. Kajihausa, 2010. Heavy metal levels of some fruits and leafy vegetables from selected markets in Lagos, Nigeria. Afr. J. Food Sci., 4: 389-393.
5. Sharma, V.K. and B.D. Kansal, 1986. Heavy metal contamination of soil and plant with sewage irrigation. Pollut. Res., 5: 86-91.
6. Yargholi, B., A.A. Azimi, A. Baghvand, A.M. Liaghat and G.A. Fardi, 2008. Investigation of cadmium absorption and accumulation in different parts of some vegetables. Am.-Eurasian J. Agric. Environ. Sci., 3: 357-364.
7. Jarup, L., 2003. Hazards of heavy metal contamination. Br. Med. Bull., 68: 167-182.
8. Qin, Y.S., J. Zhao and Z.Q. Liu, 2008. Study on the influences of combined pollution of heavy metals Cu and Pb on soil respiration. J. Anhui Agric. Sci., 36: 1117-1128.
9. Zhang, W., F. Jiang and J. Ou, 2011. Global pesticide consumption and pollution: With China as a focus. Proc. Int. Acad. Ecol. Environ. Sci., 1: 125-144.
10. Abdullateef, B., B.G. Kolo, I. Waziri and M.A. Idris, 2014. Levels of heavy metals in soil as indicator of environmental pollution in Maiduguri, Borno state, Nigeria. Bull. Env. Pharmacol. Life Sci., 3: 133-136.
11. Balkhair, K.S. and M.A. Ashraf, 2016. Field accumulation risks of heavy metals in soil and vegetable crop irrigated with sewage water in Western region of Saudi Arabia. Saudi J. Biol. Sci., 23: S32-S44.
12. Anhwange, B.A., J.A. Kagbu, E.B. Agbaji and C.E. Gimba, 2009. Trace metal contents of some common vegetables grown on irrigated farms along the banks of River Benue within makurdi metropolis. Electronic J. Environ. Agric. Food Chem., 8: 1150-1155.
13. Chove, B.E., W.R. Ballegu and L.M. Chove, 2006. Copper and lead levels in two popular leafy vegetables grown around Morogoro municipality, Tanzania. Tanzania Health Res. Bull., 8: 37-40.
14. Farooq, M., F. Anwar and U. Rashid, 2008. Appraisal of heavy metal contents in different vegetables grown in the vicinity of an industrial area. Pak. J. Bot., 40: 2099-2106.
15. Elbagermi, M.A., H.G.M. Edwards and A.I. Alajtal., 2012. Monitoring of heavy metal content in fruit and vegetables collected from production and market sites in the Misurata area of Libya. ISRN Anal. Chem., 10.5402/2012/827645.

16. Adewuyi, G.O., F.A. Dawodu and N.N. Jibiri, 2010. Studies of the concentration levels of heavy metals in vegetable (*Amaranthus caudatus*) grown in dumpsites within Lagos metropolis, Nigeria. Pac. J. Sci. Technol., 11: 616-620.
17. Doherty, V.F., U.C. Kanife, M.K. Ladipo and A. Akinfemi, 2011. Heavy metal levels in vegetables from selected markets in Lagos, Nigeria. Elect. J. Agric. Environ. Food Chem., 10: 1887-1891.
18. Kudirat, L.M. and D.V. Funmilayo, 2011. Heavy metal levels in vegetables from selected markets in Lagos, Nigeria. Afr. J. Food Sci. Technol., 2: 18-21.
19. Aweto, A.O. and G.W. Ogurie, 1992. Impact of intensive market gardening on the nutrient status of hydromorphic soil in the Ojo area of Lagos metropolis, Nigeria. Environmentalist, 12: 223-230.
20. Khan, S., R. Farooq, S. Shahbaz, M.A. Khan and M. Sadique, 2009. Health risk assessment of heavy metals for population via consumption of vegetables. World Applied Sci. J., 6: 1602-1606.
21. Eze, M.O. and E.O. Ekanem, 2014. Bioaccumulation and mobility of cadmium (Cd), lead (Pb) and zinc (Zn) in green spinach grown on dumpsite soils of different pH levels. Bull. Environ. Pharmacol. Life Sci., 4: 85-91.
22. Chiroma, T.M., R.O. Ebewele and F.K. Hymore, 2014. Comparative assessment of heavy metal levels in soil, vegetables and urban grey waste water used for irrigation in Yola and Kano. Int. Refereed J. Eng. Sci., 3: 1-9.
23. Hu, Y., X. Liu, J. Bai, K. Shih, E.Y. Zeng and H.Cheng, 2013. Assessing heavy metal pollution in the surface soils of a region that had undergone three decades of intense industrialization and urbanization. Environ. Sci. Pollut. Res., 20: 6150-6159.
24. Cicek, A., A.S. Koparal, A. Aslan and K. Yazici, 2007. Accumulation of heavy metals from motor vehicles in transplanted lichens in an urban area. Commun. Soil Sci. Plant Anal., 39: 168-176.
25. Ogbonna, P.C. and V.I. Okeke, 2011. Metal content of soil and macronutrient of gmelina leaves in Umuahia, Nigeria. J. Applied Sci. Environ. Sanit., 6: 15-22.
26. Doherty, V.F., T.O. Sogbanmu, U.C. Kanife and O. Wright, 2012. Heavy metals in vegetables collected from selected farm and market sites in Lagos, Nigeria. J. Environ. Sci. Toxicol., 1: 137-142.
27. Olowu, R.A., A.O. Eruola, A.A. Denloye, O.A. Lawal and A. Akerele, 2015. Potential toxic metal concentrations in frequently consumed leafy vegetables from markets and farmlands along Owode-Seme border, Nigeria. Resour. Environ., 5: 152-158.
28. Yusuf, K.A. and S.O. Oluwole, 2009. Heavy metal (Cu, Zn, Pb) contamination of vegetables in urban city: A case study in Lagos. Res. J. Environ. Sci., 30: 292-298.
29. Adesuyi, A.A., K.L. Njoku, M.O. Akinola and A.O. Jolaoso, 2018. Biomonitoring of heavy metals level in wetland plants of Lagos Lagoon, Nigeria. J. Applied Sci. Environ. Manage., 22: 1489-1498.