Research Journal of Environmental and Earth Sciences 4(4): 371-375, 2012
ISSN: 2041-0492

Submitted: September 21, 2011 Accepted: November 04, 2011 Published: April 15, 2012

Heavy Metal Contamination of Green Leafy Vegetable Gardens in Itam Road Construction Site in Uyo, Nigeria

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Abstract: Human exposure to heavy metals is a subject of public health concern that have attracted the attention of researchers, health and nutrition experts all over the world. Green Leafy Vegetables (GLVs) are important part of diets in the South-South Region of Nigeria. Consumption of vegetables exposed to heavy metals contamination may lead to serious health complications. In this investigation, we estimated the concentrations of some heavy metals (Pb, Hg, Al, Cd, Fe and Zn) in GLVs harvested from vegetable gardens in the residential areas along Itam road construction site, Uyo, Nigeria. The results showed that Pb, Hg, Al and Cd concentrations were significantly high ($p<0.05$) in all exposed GLV samples than the control but *Teliferia occidentalis* had higher values of heavy metals than *Talinium triangulare.* However, zinc and iron levels in the GLV exposed samples were not significantly ($p>0.05$) higher than the control. Our findings showed that heavy metal contamination of edible vegetable is high at road construction sites and may impact negatively on the health of human and animals living in such environment. We suggest that health impact assessment be carried out at construction sites in order to suggest necessary measure that can alleviate the effects of such environmental contaminants.

Key word: Health impact, heavy metals, nutrition, toxicity

INTRODUCTION

Road construction work, manufacturing and the use of advanced technology may result in heavy metals contamination of urban and rural environment. Heavy metals also occur naturally, but rarely at toxic levels. Heavy metals occur as natural constituents of the earth crust and are persistent environmental contaminants since they cannot be easily degraded or destroyed (Ioan *et al*., 2008). Heavy metals enter the body system through food, air and water and bio-accumulate over a period of time. (Duruibe *et al*., 2007). Excess heavy metal accumulation in the environment is capable to have toxicological implication in humans and other animals.

Construction of roads as a result of urbanization is a welcome development for any nation to grow economically but these are not without their environmental and health impact. During road construction, dust of different particle sizes and composition are generated. The consequence of this is an environment heavily contaminated by metals from dust generated by heavy duty equipment.

Heavy metal pollution is of significant ecological/environmental concern. This is due to the fact that they are not easily biodegradable or metabolized, thus precipitating far reaching effects on the biological system such as human, animals, plants and other soil biota (Yoon, 2003). Researchers have also stressed that these metals could bioaccumulate in crops, especially when cultivated along construction sites and are consumed by man and livestock (Tulonen *et al*., 2006). Human exposures to heavy metals have been the focus of increasing attention among researchers, health and nutrition experts due to their impact on public health. Green Leafy Vegetables (GLVs) are important part of diets in the South-South Region of Nigeria. Consumption of vegetables exposed to heavy metal contamination may be of serious health consequences.

Green Leafy Vegetables (GLV's) are predominantly known for their high nutritional content and are mostly consumed for their health and nutritional benefits. In the South-South region of Nigeria, domestic vegetable gardening is a common practice because GLVs constitute a major component of the diets and is of great economic values.

The aim of this study is to analyze two Nigerian vegetables (*Teliferia occidentalis* and *Talinium triangulare*) for the level of some heavy metals (Pb, Hg,

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Table 1: Heavy metal concentration (mg/kg) in pumpkin leaves obtained from Itam road construction site

Sample type	Lead (Pb) mg/kg	Mercury (Hg) mg/kg	Aluminum (Al) mg/kg	Iron (Fe) mg/kg	Cadmium (Cd) mg/kg	Zinc (Zn) mg/kg
1	0.004	0.003	0.400	5.000	0.001	1.000
2	0.005	0.004	0.500	5.000	0.002	1.700
3	0.003	0.004	0.420	5.580	0.001	1.210
Control	0.003	0.002	0.270	4.350	<0.001	0.980

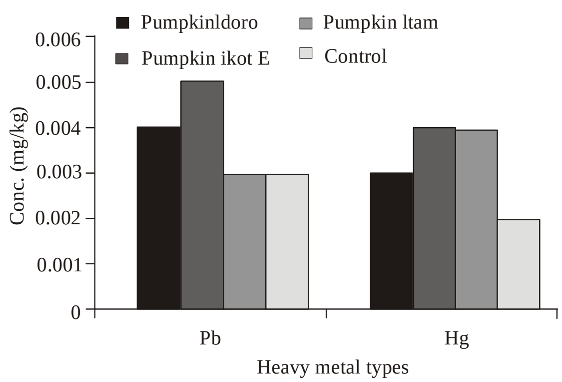

Fig. 1: Pb and Hg concentrations in *Telferia occidentalis* samples from Itam road construction site

Al, Cd, Fe and Zn). Also, to compared samples obtained from control sites that of road construction and dust contaminated sites.

MATERIALS AND METHODS

Study area: The study was carried out in Uyo (a town located within latitude 9ºN and longitude 3ºE (9ºN3ºE)), the capital city of Akwa Ibom State in the South-South region of Nigeria, in the month of March 2010. Samples were collected at Atiku Abubakar, Idoro and Ikot Ekpene Roads where the State Government embarked on fly over and road construction. These locations lie within the Itam junction extension in Uyo municipality. Control samples were collected from Atan Offot village few kilometers from the construction site still in Uyo, Nigeria.

Collection and treatment of samples: Freshly harvested leafy vegetables: water leaves (*Talinium triangulare*) and pumpkin leaves (*Teliferia occidentalis*) and soil samples were collected from different marked sites/locations into different labeled polyethylene bags. The samples were transported to a Laboratory in Biochemistry department, University of Uyo, Nigeria. The samples were washed with de-ionized water and spread on clean plastic trays to allow the water to drain off. The samples were packed into a labeled brown envelops and dried in the Gallenhkamp oven at a temp of 65ºC for 4 days. After drying, the samples were pulverized into fine powdery form. The soil samples were sieved using 2 mm sieve to obtain very fine particles. Drying continued until all the wet samples reached a constant weight.

Five (5) g of dried samples each was transferred into digestion flasks, 4 ml perchloric acid and 8 mL nitric acid were added to the respective. The digestion flasks were then put on a hot plate set to 120ºC (gradually increased) until the samples were digested. After digestion the digested samples were diluted with distilled water appropriately in the range of standards which were prepared from stock standard solution of the metals (APHA and WCPF, 1998; IAEA/UNEP/FOA/IOC, 1984). Heavy metal concentrations in the samples were measured using a Perkin Elmer AS 3100 flame atomic absorption spectrophotometer.

Statistical analysis: Analysis of variance was performed on each measured variable and means and Standard Errors (SE) were calculated. The least significant difference ($p<0.05$) was used for multiple comparison among treatment mean using the SPSS software package.

RESULTS

The result of the heavy metals analysis of pumpkin leaves obtained from Itam road construction site is presented in Table 1 (Fig. 1). The results showed a high concentration of lead (Pb) and mercury (Hg) in all the samples collected than the control samples.

Aluminum level in pumpkin leave samples from the construction site were significantly higher ($p<0.05$) than the control site. The highest concentrations of Pb, Al and Hg were found in samples closer (<150 m) to the construction site.

However, Iron (Fe), cadmium (Cd) and zinc (Zn) concentrations (mg/kg) were higher in test samples than control samples, but the increase was not significant ($p>0.05$).

Table 2, (Fig. 2), shows the results of the concentration of heavy metals in water leaf samples. Surprisingly, lead (Pb) concentration (mg/kg) reported in this investigation is significantly ($p<0.05$) lower than the control sample, while mercury (Hg) and Aluminum (Al) concentrations increased significantly ($p<0.05$) in all the groups when compared with their controls. Iron concentration (mg/kg) decreased in all the groups excepts for a slight increase observed in the samples collected from the location, 200 m from the construction site. Also, zinc concentration increased significantly in GLV

Table 2: Heavy metal concentration (mg/kg) in water leaves obtained from Itam road construction site

Sample Type	Lead(Pb) Mg/kg	Mercury(Hg) Mg/kg	Aluminum(Al) Mg/kg	Iron(Fe) Mg/kg	Cadmium(Cd) Mg/kg	Zinc(Zn) Mg/kg
1	0.002	0.004	0.360	5.000	0.002	1.320
2	0.002	0.003	0.970	1.360	0.003	2.340
3	0.003	0.003	0.490	4.410	0.001	1.100
Control	0.001	0.001	0.200	4.780	0.002	1.090

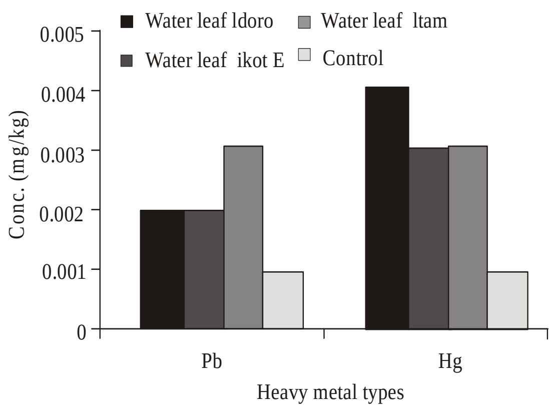

Fig. 2: Pb and Hg concentrations in *Telferia triangulae* samples from Itam road c construction site

samples collected, but the samples from distance <150 m did not show any significant (p>0.05) increase.

The result of heavy metal concentrations (Pb, Al, Cd) in soil samples are shown in Table 3 (Fig. 3). We observed that the Pb, Al, Cd concentrations of the soil samples were not statistically different from that of control. However, Hg concentration significantly increased (0.004 mg/kg) than the control (0.001 mg/kg). Iron and Zinc decreased in the soil sample when compared with the control except the value of iron in sample 3 which was high than the control.

Generally, our findings showed that pumpkin leaves contain high levels of heavy metals than the water leaf samples but the soil samples did not contain much heavy metal like the GLV samples. The increased concentration of heavy metal in GLVs could be due to uptake, bioaccumulation and metal dust contamination. We therefore advise that consumption of GLV should be restricted to those obtained from metal dust free environment. Residential area should be pre-planned and developed before occupation by the residents.

DISCUSSION

The quest for aesthetics and better living condition is a welcome development especially in developing nations like Nigeria. However, there must be a balance between development and health, hence the need for proper risk assessment on any project. In this study, we observed a very high population of people residing or doing business in and around construction sites. Most of these residents do practice small scale vegetable gardening from where they harvest vegetable products for domestic and commercial purposes. Consumption of dust-laden vegetable, especially where the hygienic practice of the people is low may be detrimental to health as dust particles may contain traces of heavy metals which may bioaccumulate in the leaves of plants and are eventually consumed by man and animals.

Our results showed that some heavy metal concentrations were high in the vegetable samples in gardens located around the construction sites in Itam, an outskirt town of Uyo, Akwa Ibom State, Nigeria. This construction work was ongoing throughout the dry season and a lot of dust were generated as a result of heavy duty earth moving equipment being put to use by the construction company (Julius Berger Construction Company PLC). Although the company put up some measures to reduce the amount of dust being generated by watering the roads intermittently, we observed that this measure was not enough to protect the health of the passers-by and people living in such a highly polluted environments.

Vegetables are major component of diets in the Niger-Delta-Region of Nigeria, hence a major source of income to most rural dwellers who practice small scale vegetable gardening. From these garden the people harvest GLVs for their consumption and also cell to the public. Consumption of dust-laden vegetables may pose a lot of health hazards to the people due to the presence of heavy metals as components of the earth crust. They are not easily degraded and may be taken into the body via food, water and air. However, at higher concentration, they may be involved in several biochemical reactions, interactions and may evoke significant changes in biosystems and population. Several studies have shown that pollution can have an influence on the stability of populations by increasing mortality and or reproductive output (Dauwea *et al*., 2004).

Our results showed that exposure to dust containing heavy metals may have contributed to the level of heavy metals reported in the GLV samples in this investigation. This is because the amount of heavy metals in the soil samples analyzed was mostly lower than those in the leaves of the GLVs harvested from the same site.This may not be far from the fact that mineral uptake from soil uptake and dust particles contribute to the mineral levels in the GLVs. Some metals (Fe, Zn and Mg)reported to be

Table 3: Heavy metal concentration (mg/kg) in soil samples obtained from Itam road construction site

Sample type	Lead(Pb) mg/kg	Mg/kgMercury(Hg) mg/kg	Aluminum(Al) mg/kg	Iron(Fe) mg/kg	Cadmium(Cd) mg/kg	Zinc(Zn) mg/kg
1	0.003	0.001	0.310	1.150	0.001	0.980
2	0.003	0.004	0.370	0.990	0.002	1.250
3	0.004	0.004	0.300	1.200	<0.001	1.720
Control	0.003	0.001	0.330	5.000	0.002	1.500

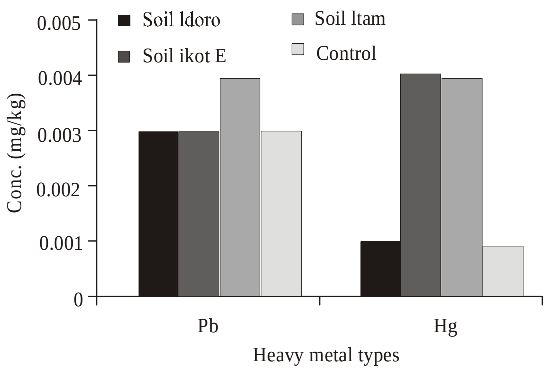

Fig. 3: Pb and Hg concentrations in soil samples from Itam road c construction site

of bio-importance to man have daily medicinal and dietary allowances reported (Radwan and Salama, 2006; FNBIM, 2001; FNBIM, 1997). Their tolerance limits in drinking and potable waters have also been reported (Hanaa *et al*., 2000; Kar *et al*., 2008; Abulude *et al*., 2007). However, some other minerals such as As, Cd, Pb and methylated forms of Hg have been reported to have no known bio-importance in human biochemistry and their consumptions at very low concentrations can be toxic to humans (Holum, 1983; Fosmire, 1990; Mc Cluggage, 1991; Ferner, 2001; European Commission, 2002; Nolan, 2003; Young, 2005).

The results of this investigation is in agreement with the results of Uboh *et al.* (2011) on the distribution of heavy metals in fluted pumpkin (*Telfeiria ocidentalis*) leaves planted at different distances away from the traffic congested highways in Calabar, Nigeria. Literature is replete with information on research works carried out on GLVs from polluted environment (Othman, 2001; Nirmal Kumar *et al*., 2004; Jassir *et al*., 2005; Sharma *et al*., 2009). It is therefore obvious that consumers of vegetables harvested from polluted environments are at greater risk of heavy metals toxicity especially pregnant women and children who depend mostly on GLVs as their major source of vitamins and other nutrients. Other researchers have reported on the health implication of excess transitional metals in biological systems to include membranes and therefore, toxicities associated with these metals may be due to oxidative damage. Studies have shown that metals such as iron, copper, cadmium, chromium, lead, mercury and nickel have the ability to produce reactive oxygen species. The result of this is lipid peroxidation, DNA damage and altered calcium homeostasis (Stohs and Bagchi, 1994; Otitoju and Onwurah, 2005). Therefore consumption of heavy metal polluted vegetables could lead to several health implications such as cardiovascular diseases and cancers. In addition, heavy metal toxicity contribute to several other diseases such as Alzheimer's disease, Arthritis, Diabetes, Fatigue and Memory Loss.

In conclusion, it is well known that environmental pollution is a product of urbanization and technology and other attendant factors of population density, industrialization and mechanization that serve to provide the necessities of the population. Monitoring and systematic gathering of information on heavy metal levels in the environment are essential components of any pollution-control system. The establishment of such a system often presupposes the existence of minimum pollution standards and regulations. This result will therefore help the government, individuals and communities to take necessary measure in controlling heavy metal pollution and to minimize exposure of people living around construction site.

ACKNOWLEDGMENT

The authors acknowledge the assistance of Divine Concept Laboratory Port-Harcourt, Nigeria for helping in the analysis of this study. We also appreciate the efforts of our students; Miss Comfort Sunday and Patrick Nnam for helping in sample collection.

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