



Spatial variation in Heavy Metal residue in *Corchorus olitorius* cultivated along a Major highway in Ikorodu- Lagos, Nigeria.

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ABSTRACT: This study focused on heavy metals (Lead (Pb), Zinc (Zn) and Cadmium (Cd)) contamination in the vegetable *Corchorus olitorius* (*C. olitorius*) leaves cultivated along a major road. Samples the vegetable, *C. olitorius* leaves) were collected from two sites, one of which is located on a major highway and the other remotely located from any form of industrial activity and which served as the control site. These samples were collected at distances of 10, 20 and 30m from the roadside and analyzed for Pb, Zn and Cd content by atomic absorption spectrophotometer. The mean concentration of heavy metals in the studied vegetable with effect to distance from the road was compared with the permissible values given by WHO/FAO. Mean concentration of heavy metal in *C. olitorius* leaves ranged from 0.013 to 0.310mg/kg, 2.500 to 4.850mg/kg and 0.063 to 0.205mg/kg at 10m, 20m and 30m distances respectively from the road. In all cases, it was observed that the closer the plants were to the road, the higher the heavy metal burden. The result of this study shows that, while the concentration of heavy metals in *C. olitorius* leaves from the control site remains constant, (i.e. showing no sign of contamination) the concentration of heavy metals in *C. olitorius* leaves cultivated along major road decreased with an increasing distance from the road.
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Many anthropogenic sources such as waste incineration, industrial processes and most importantly, vehicular traffic emits heavy metals into the atmosphere (Turkdogan *et al*; 2002). The contamination of vegetables with heavy metals due to soil and atmospheric contamination poses a threat to its quality and safety. Dietary intake of heavy metals also poses risk to animals and human health. High concentrations of heavy metals such as copper (Cu), cadmium (Cd) and lead (Pb) in fruits and vegetables were related to high prevalence of upper gastrointestinal cancer (Turkdogan *et al*, 2002). The uptake and bioaccumulation of heavy metals in vegetables are influenced by many factors such as the prevailing climatic condition, depositions from the atmosphere, the concentration of heavy metals in soil, the nature of soil and the degree of maturity of the plants at harvest. (Scott *et al*, 1996; Vousta *et al*, 1996).

Cultivation areas near highways are exposed to atmospheric pollution in the form of metal containing aerosols. These aerosols can be deposited on soils and absorbed by vegetables, or alternatively deposited on leaves and fruits and then absorbed. Voutsas *et al* (1996) and De Nicola *et al* (2008) reported in their work high accumulation of Pb, Cr and Cd in leafy vegetables due to atmospheric depositions. The levels of heavy metals such as zinc (Zn), manganese (Mn), copper (Cu) and lead (Pb) in *Talinum triangulare* in dumpsites in Lagos, Nigeria were found to be high due to vehicular traffic emission. (Adeniyi, 1996).

In many cities in the developing world, lack of access to land make other lands including hazardous places such as road verges, banks of drainage channels and dumpsites converted to vegetable gardens. All setbacks along major highways are used by farmers for vegetable cultivation. (Adeniyi, 1996).

Corchorus olitorius is one of the popular edible vegetables in Nigeria. *Corchorus olitorius* is usually recommended for pregnant women and nursing mothers because it is believed to be rich in iron (Oyedele *et al*, 2006). *C. olitorius* is widely consumed with a variety of food particularly in South Western Nigeria where it is locally referred to as "ewedu", "ooyo" or "obeeyo". The Hausa people of Nigeria and their Fulbe neighbors call it "rama." They use it to produce soup ("taushe") or boil the leaves and mix it with "Kuli-kuli" or groundnut cake and consume the mixture which they call "kwado" in Hausa (Denton, 1997). According to Burkill (2000), *C. olitorius* is used in Kenya to treat toothache, in Congo, the leafy twigs are used against heart troubles, an infusion from the leaves is taken in Tanzania against constipation and in Nigeria, and the seeds are taken as a purgative.

The objectives of this work are to determine the extent of contamination of vegetables cultivated along major road with toxic heavy metals from traffic emission and to determine the effect of distance from the road on the heavy metal content of the vegetables.

MATERIALS AND METHODS

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Spatial variation in Heavy Metal.....

Study area: This study was conducted on a site immediately adjoining the ever busy Ikorodu-Sagamu express road, Ikorodu, Lagos State, Nigeria. The road is a major highway with a heavy vehicular movement throughout the day. Lagos State Government farm settlement, Amuludun Agricultural Cooperative Society located along this busy road was selected as the study site. In this farm settlement, there is a barrier (a fence) at a distance of about 20m from the Highway. The control site used was Lagos State Polytechnic farm located inside Lagos State polytechnic, Ikorodu. This control site was at a distance of about 1500meters from this major highway of Ikorodu-Shagamu express road. The nearest motorable road to the control site is the access road within the Polytechnic campus, and this intra campus access road is about an estimated distance of 50m from the control site. This road has very little vehicular movement during the day, and a near zero movement at night. The control site was therefore chosen at distances of 10m, 20m and 30m from the edge of the plot in the Polytechnic farm where this *C. olitorius* was planted. The control site proper however is characterized by zero vehicular movement. Also, it is remotely located from any form of industrial activity.

Collection of samples: The samples (*C. olitorius* leaves) were collected biweekly during the mid rainy season of October and November, 2010. Samples of *C. olitorius* leaves were taken at distance intervals of 10, 20 and 30 meters from the highway on the experimental site. Three samples were taken for each of the distances along a horizontal transect at 10m interval denoted as A, B and C. The coordinates for the sampling area is between 26 N (06°39.092'), E (003°31.138') and N (06°39.087'), E (003°31.160'), while that of the control area is 31, N (06°38.926'), E (003°31.205'), and 26 N (06°39.940'), E (003°31.204'). All three samples per point were mixed together to form a composite sample each and the three composite samples were then packed into paper bags, labeled and taken to the laboratory for analysis within (at most) 3hour interval from the time samples were collected. The vegetable samples were analyzed for heavy metal content namely lead (Pb), Zinc (Zn) and Cadmium (Cd).

Procedure for the digestion of vegetable samples: 5g of vegetables (*C. olitorius* leaves) was taken into 250ml conical flask. 10ml of Concentrated HNO₃ (nitric acid) was added to it and the mixture was evaporated on a Hot- plate in a fume cupboard until the brown fumes disappears leaving the white Fumes. This mixture was then brought to room

temperature, and it was made up to 50ml mark with distilled water. The sample was then filtered into a sample bottle using a funnel and Whatman's filter paper no 4 and it was ready for Atomic Absorption Spectrophotometer (A.A.S) reading. PerkinElmer A Analyst 400 model of A.A.S was used.

Determination of heavy metals in the digested vegetable samples using A.A.S: The readings were taken from the equipment at wavelength 217.00 (Pb), 213.86 (Zn) and 228.80 (Cd), then the results were converted to actual concentration of metals in samples using the equation;

$$\text{Conc (mg/Kg)} = \frac{\text{CR} \times \text{VE}}{\text{WS}}$$

Where CR = Calibration reading is the value of the reading obtained from the A.A.S equipment; VE = Volume of extract is the final volume of the digest used for spectrophotometric analysis; WS = Weight of sample is the weight of the sample digested.

Analysis of data: Data collected were subjected to statistical analysis by Analysis Of Variance (ANOVA). Means were separated using Least Significant Difference (LSD) at 5% and 1% level of confidence. Test of significance were conducted for each of the elements for the following: Mean concentration for heavy metals Lead (Pb), Zinc (Zn) and Cadmium (Cd) in *C. olitorius* leaves at different distances (10m, 20m and 30m) in the study site and control site (tables 1a, 2a and 3a). Mean concentration for heavy metal concentrations in *C. olitorius* leaves at the different distances between the study site and the control site (tables 1b, 2b and 3b). The mean concentration of Pb obtained in *C. olitorius* leaves at at distances of 10m, 20m and 30m from the road

RESULTS AND DISCUSSION

Lead (pb): In the study site, the mean concentration of Pb obtained in *C. olitorius* leaves at the distances of 10m, 20m and 30m from the highway were 0.310mg/kg., 0.120mg/kg and 0.013mg/kg respectively. At the control site however, Pb was not detected in the leaves of *C. olitorius* in all the distances (table 1a). It should be noted that the value of Pb at 10m in the study site exceeded the FAO/WHO permissible limit.

Spatial variation in Heavy Metal.....

Table 1a: Mean concentration of Lead (Pb) (mg/kg) in *C. olitorius* leaves from study site and control sites at 1% level of significance. *ND – Not detectable. Values carrying different superscripts differ significantly.*

Distance (meters)	Study site	Control site	FAO/WHO Limit IN VEGETABLES.
10	0.310 ^a	ND	0.30
20	0.120 ^b	ND	0.30
30	0.013 ^c	ND	0.30

Using the different distances as the baseline, a comparison of the means at the different distances of 10m, 20m and 30m between the study site and the control site for Pb could not be compared as Pb was not detected in the control site (table 1b).

Table 1b: Comparison between the mean concentration of Pb in *C. olitorius* leaves at the different distances both at the study and control sites at 1% level of significance. *ND – Not detectable.*

Distance (metres)	Lead (Pb) mg/kg	
	Study site	Control site
10	0.310 ^a	ND
20	0.120 ^a	ND
30	0.013 ^a	ND

Cadmium: Like Pb, there was significant difference in mean concentration of Cd in *C. olitorius* leaves at the different distances considered at 1% level of significance at the study site. The mean concentration of Cd at distances of 10m, 20m and 30m in the study site were 0.205mg/kg, 0.140mg/kg and 0.063mg/kg respectively. There was no significant difference among the mean concentration of Cd in the leaves of *C. olitorius* at the different distances in the control site. The means were 0.058mg/kg, 0.050mg/kg and 0.055mg/kg at 10m, 20m and 30m respectively at the control site (table 2a). At 10m in the study site, the level of cadmium exceeds slightly the level permissible by WHO/FAO, while at other distances, and especially at the control, the level of Cd. fell well below the permissible level in vegetables (table 2a). Table 2b shows a significant difference between the mean levels of Cd in *C. olitorius* leaves at the different distances in the study site and control except however at 30m in both treatments where there was no significant difference.

Table 2a: Mean concentration of Cadmium (Cd) (mg/kg) in *C. olitorius* leaves from study site and control site at the different distances at 1% level of significance. *values carrying different superscripts differ significantly.*

Distance (metres)	Study site	Control Site	FAO/WHO Limit in Vegetables
10	0.205 ^a	0.058 ^a	0.200
20	0.104 ^b	0.050 ^a	0.200
30	0.063 ^c	0.055 ^a	0.200

Table 2b: Comparison between the mean concentration of Cd in *C. olitorius* leaves at the different distances both at the study and control sites at 1% level of significance. *Values carrying different superscripts differ significantly*

Distance (meters)	CADMIUM (Cd)Mg/Kg	
	Study site	Control site
10m	0.205 ^a	0.058 ^b
20m	0.140 ^a	0.055 ^b
30m	0.063 ^a	0.050 ^a

Zinc: The result shows that there was significant difference in the concentration of Zn in *C. olitorius* leaves at distance 10m from the road when compared with the distances 20m and 30m, while at 20m and 30m there was no significant difference in Zn concentration in *C. olitorius* leaves at the study site (Table 3a). The mean concentration of Zn in *C. olitorius* leaves at distances 10m, 20m and 30m from the Highway were 4.850mg/kg, 3.138mg/kg and 2.500mg/kg respectively. The level of Zn in the 10m distance at the study site differ significantly from those of the other two distances here. At 20m and 30m however there was no significant difference. In the control site the mean concentration of Zn at distances of 10m, 20m and 30m from the edge of the farm were 1.513mg/kg, 1.500mg/kg and 1.508mg/kg in *C. olitorius* leaves respectively. The result shows that there was no significant difference in Zn concentration in *C. olitorius* leaves in the control site (Table 3).

Table 3a: Mean concentration of Zinc (Zn) (mg/kg) in *C. olitorius* leaves from study site and control site at 1% level of significance. *Values carrying different superscripts differ significantly at both levels of significance*

Distance (metres)	Study site	Control Site	FAO/WHO Limit in Vegetables
10	4.850 ^a	1.513 ^a	60
20	3.138 ^b	1.500 ^a	''
30	2.500 ^b	1.508 ^a	''

A comparison of the means between the study and the control sites showed that there was a significant difference between them at 10m and 20m while at 30m, there was no significant difference between the study site and the control site (table 3b).

Table 3b: Comparison between the mean concentration of Zn in *C. olitorius* leaves at the different distances both at the study and control sites at 1% level of significance. *Values carrying different superscripts differ significantly.*

Distance (meters)	Zn Mg/kg	
	Study site	Control site
10m	4.850 ^a	1.508 ^b
20m	3.138 ^a	1.513 ^b
30m	2.500 ^a	1.500 ^a

Spatial variation in Heavy Metal.....

From the foregoing, the effect of distance on the level of heavy metal residue in vegetables is evident. In all cases, it was observed that the closer the plants were to the road, the higher the heavy metal burden. This finding agrees with the findings of Atayese *et al.* (2009) where the levels of Pb and Cd in two agricultural soils were monitored at different distances from the road. At 10m from the road, the concentration of lead (Pb) in both soil and leaves of *C. olerarius* at the study site was higher than the permissible limits given by WHO and FAO (2001), this can be attributed to effect of lead discharge from automobiles (Igwegbe *et al.*, 1992). At distance 20m and 30m from the road, the concentration of lead was below the permissible level. As reported by WHO (1995), health implications of lead in children may include behavioral disturbances, learning and concentration difficulties and people who may have been exposed to lead for a long time may suffer from memory deteriorations, prolonged reaction time and reduced ability to understand.

Cadmium content in *C. olerarius* leaves exceeded the permissible limits at distance of 10m from the road. This could be ascribed to rough surfaces of the roads which increase the wearing of tyres and runoff from road side (Hewitt and Rasheed, 1988). It could also be from vehicular emissions due to nearness to the road of these plants, a finding which further agrees with the report by Jarup *et al.* (1998) that emission from heavy traffic also leads to the increase in cadmium concentration in plants along highways.

The significant decrease in the content of these heavy metals (Pb, Zn, and Cd) at 20m from the road can be outrightly ascribed to the presence of a barrier (wall or fence) present at the site at distance 20m and this strongly corroborate the suggestion that construction of barriers between roadsides and gardens could reduce the amount of heavy metals accumulated by the crops from the emissions and other aerial sources (Atayese *et al.*, 2001). Therefore, the concentration of heavy metals in the leaves of *C. olerarius* at distance of 10m from the road at the study site could be due to aerial deposition of heavy metals. (e.g from automobile exhaust) on the leave surfaces. The mean concentration of all three heavy metals (Pb, Zn and Cd) considered in this study at distance of 30m from the road were considerably below the permissible values for food recommended by (FAO/ WHO, 2001), this result is in line with those of (Rodríguez *et al.*, 1992) who reported that, accumulation of lead and cadmium above background level takes place up to a distance of approximately 33m from the road.

From the results obtained from this study, it is obvious that the nearer a vegetable is to the highway, the higher the heavy metal load. It can be suggested that vegetables should be planted at distance of not less than 30m from major roads and that in addition, barriers (walls) of about 2.5m in height should be constructed along the planting site as this appears to reduce the direct deposition of the heavy metal fall-out from the automobiles sources on both the plant and soil.

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Spatial variation in Heavy Metal.....

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