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Evaluation of Heavy Metals Contamination in some Irrigated Vegetables from Kano, Nigeria

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ABSTRACT

The content of Pb and Cr in some vegetables (viz lettuce, onion, carrot, tomato, pepper and amaranthus) grown on irrigated farm lands in the vicinity of Sharada industrial waste water drainage basin at Kaba village, Challawa, Kano, Challawa-Yandanko rivers and Thomas Dam, Danbatta, Kano, Nigeria were evaluated. It is situated at 8° 29` 42” to 8° 30` 54” E longitude and 11° 5`18” to 11° 5` 54” N latitude, also 8° 30` 18” to 8° 31` 30”E Longitude and 12° 17` 6” to 12° 16` 30”N Latitude. The objectives have been mainly to determine Cr, and Pb in edible parts of these vegetable samples which were frequently consumed by people in Kano and other parts of Nigeria in order to compare the heavy metals contents with the results obtained in analogous studies carried out in relation to the permissible limits specified by WHO/FAO, standards. Samples of vegetable were obtained in the dry season for the year 2018 from upstream and downstream portion of the sample sites. Analyses for the concentration of these heavy metals (Pb and Cr) were conducted by the use of Mass plama-Atomic Emission spectrometry (MP-AES) method. The Data obtained were expressed in terms of descriptive statistics while the figures were presented with mean values of three replicates. The statistical significance was computed using pair samples T-test to test the variation among the heavy metals in the vegetables and sites with a software JMP4 version 14. Results for the study indicated that concentration values of Pb (0.71-8.39 mgkg^{-1}) and (Cr 9.58-28.30 mgkg^{-1}) were higher than WHO/FAO maximum permissible limits for (Pb 0.3mgkg^{-1}) and (Cr 2.3mgkg^{-1}). The two way Anova test showed significant differences by farming site, vegetable type and their interaction. Furthermore, the study revealed that some areas of the sample site were more polluted by a particular metal than the other due to the revealing and anthropogenic activities such as the use of untreated industrial and municipal effluents, pesticides, fertilizer supplements for irrigation purposes in the area. Therefore, consumers of these vegetables run the risk of health problems like elevated blood pressure, developmental and neuro-behavioural effects on fetuses, in infants and children, cardiovascular, tubular dysfunction in kidneys and nervous disorders due the elevated concentrations of Cr and Pb in the vegetables.

Keywords: Effluent, Heavy metals, Kano, Nigeria, Vegetables

INTRODUCTION

Heavy metals are among the major contaminants of food supply and may be considered to be the major problem to our environment. Such problem is getting more serious all over the world especially in developing countries such as North and South Africa, Turkey, Yemen, Zimbabwe, Nigeria, Tanzania and Egypt. These metals are given special attention throughout the globe due to their toxic and mutagenic effects even at very low concentration, (Maleki and Zarasvand 2008; Sharma *et al.,* 2009).Heavy metals occur naturally in soils and some of these such as copper (Cu), Zinc (Zn) and Cobalt (Co) play an important role in the nutrition of plants and animals, while others such as Lead (Pb), Arsenic (As) and chromium (Cr) have deleterious effects on various components of the biosphere. Normally these elements are present in the soil at concentrations or forms that do not pose risk to the environment as reported by Silva *et al* (2009), but their levels can be altered by different anthropogenic routes.

Both natural and anthropogenic sources are responsible for increasing the levels of heavy metals in the environment. Natural sources include parent geologic rock material, volcanic outcropping, spontaneous contributions or forest fires, whereas anthropogenic sources include sewage sludge, pesticides, organic matter, composts, fertilizer supplements (Lopez-Alonso *et al* 2000), industrial waste, mining, smelting and metallurgical industries and use of treated or untreated industrial and municipal effluents for irrigation purposes (Barman *et al* 2000; Mapanda *et al* 2005; Sharma *et al* 2006; Singh and Kumar; 2006).

The heavy metals available to plants are present in air, water as well as soil and sediments. The heavy metals cadmium, Lead and mercury are common air pollutants being emitted mainly as a result of various industrial activities. Although the atmospheric levels are low, they contribute to the deposition and build-up in the soils. Plants are able to take-up heavy metals from all these media depending on their concentrations.

Therefore, Samples of industrial effluents from Sharada and Challawa industrial areas Kano, Nigeria were assessed for heavy metals. The study showed that about 60% of the industries discharge effluents with heavy metals (Cynthia *et al* 2012). Concentration higher than 0.3 mg/l lead and chromium ions were the most prevalent with values above minimum tolerable limit, since a decade these pollutants are being transferred from Challawa and Sharada industrial areas to Challawa and Kano rivers. After polluting Challawa river and turning huge tracts of agricultural lands barren besides posing a serious public health hazard, industrialists are shifting the effluents to downstream of Challawa river. The effluents do not undergo any primary treatment, it travels in to the river and mixes with the river water and eventually into the river Kano. The inorganic pollutants such as heavy and toxic metals tend to accumulate in the environmental segments near and downstream of Challawa and Kano rivers. The presence of these metal ions could pose a serious public health hazard. Therefore, Lead can occur naturally in plants as a result of the processes of taking up the Lead normally found in the soil. Lead forms and contents in the vegetables vary greatly with species and depend principally on the environmental conditions because contaminated soils can induce Lead accumulation by crops (Nan *et al*., 2002). Lead accumulation by crops grown on soils contaminated with abnormally elevated level of metals poses a risk to human health.

Chromium may be present in both trivalent and hexavalent oxidation states in most environmental samples. and its fate depends on the oxidation state. Chromium (VI) readily penetrates cell membranes. Once transported through the cell membrane, chromium (VI) is readily reduced to chromium (III) which subsequently binds to macromolecules. In humans chromium accumulate in the lung, spleen, liver and kidneys. Also, chromium (VI) compounds causes mutation and allied effects such as chromosomal aberrations. Thus the need to carry out extensive screening on the vegetables grown in the vicinity of our riversand Dams in order to have an over view of the levels of heavy metals in our vegetables crops. It was in this regard that the vegetables which are some of the crops grown for commercial purposes were screened in order to access the level of the trace metals in the vegetable crops in the area. (Abdullahi *et al*., 2007).

Materials and Methods

All regents used were of analytical reagent grade. A clean laboratory and a fumehood were used for preparing the samples, distilled deionised water was used throughout. All solutions were stored in high density polyethylene bottles. All glass wares were cleaned by soaking in 10 % (v/v) HNO_3 for 24 hours rinsing five times with deionised water and dried in an oven before use. All operations were performed on a clean laboratory bench.

Selection of Sampling Sites and Vegetables:

Six samples of vegetable (viz: onion, tomato, carrot, pepper, lettuce and amaranthus) were obtained from different agricultural site exposed to varying degrees of environmental pollution. These farmlands were grouped into three on the basis of the types of water that is being used for the irrigation in the area. Farmlands irrigated with wastewater are designated as RCIW, SIWW (1.e River Challawa-Industrial water and Sharada industrial waste water). The second group is referred to as Kano River Well Water (KRWW) and River Chalawa-Yandanko Water (RCYW). (I.e. farmlands irrigated with well water). The third category Thomas Dam Water (THDW) is farmlands receiving their irrigation water from Thomas Dam, Danbatta. The fourth sampling site includes irrigation farms at the bank of river Challawa which was directly polluted with Challawa industrial effluent. The fifth location was situated at Thomas Dam, Danbatta.

Description of the study area:

The study areas were agricultural fields along river Challawa – Yandanko and Kano River near Magasawa and Kauran Mata villages that uses shallow well water for irrigating their crops. Another site is situated at Kaba village (Fig. I) where the irrigation farms surrounds the drainage basin, which along it course receives effluent from various industries such as Hamatan Ternary (HMT), Nigerian Bottling Company plc (NBC) Challawa, Maria Jose Ternary (MRJ) as well as municipal and untreated wastewater from various settlements which collects and drains off into a common outlets and finally into Challawa river (Fig. 1). Thomas Dam, Danbatta is located 49km away from Kano municipal (Fig.2).

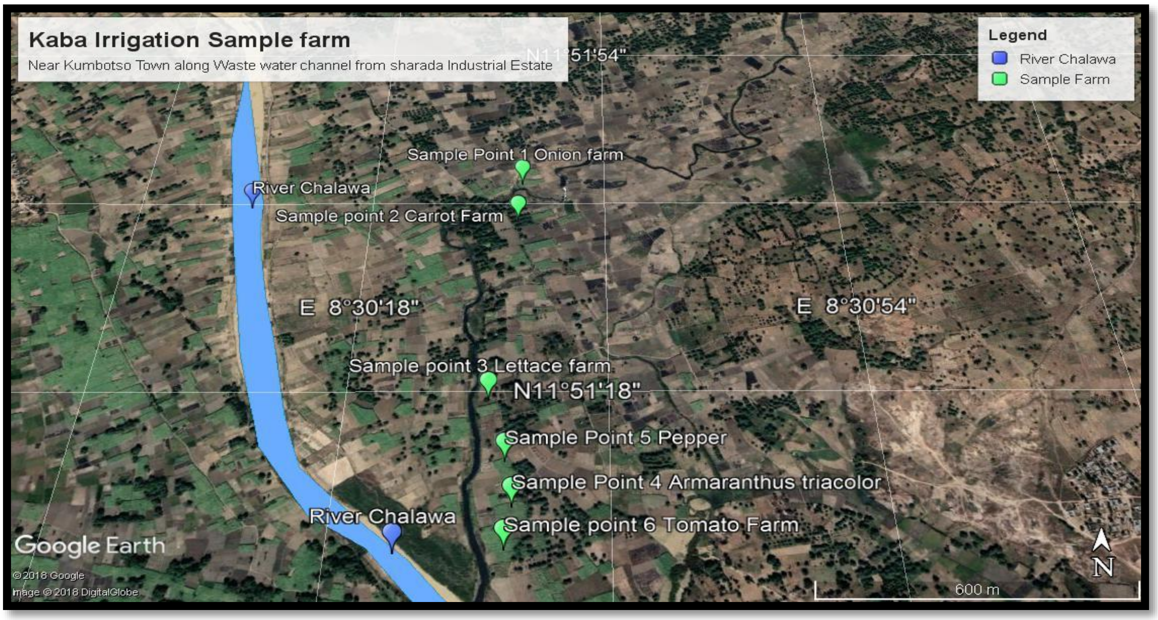

Figure 1. Map of Sharada industrial area showing Kaba Wastewater irrigation farms (SIWW)

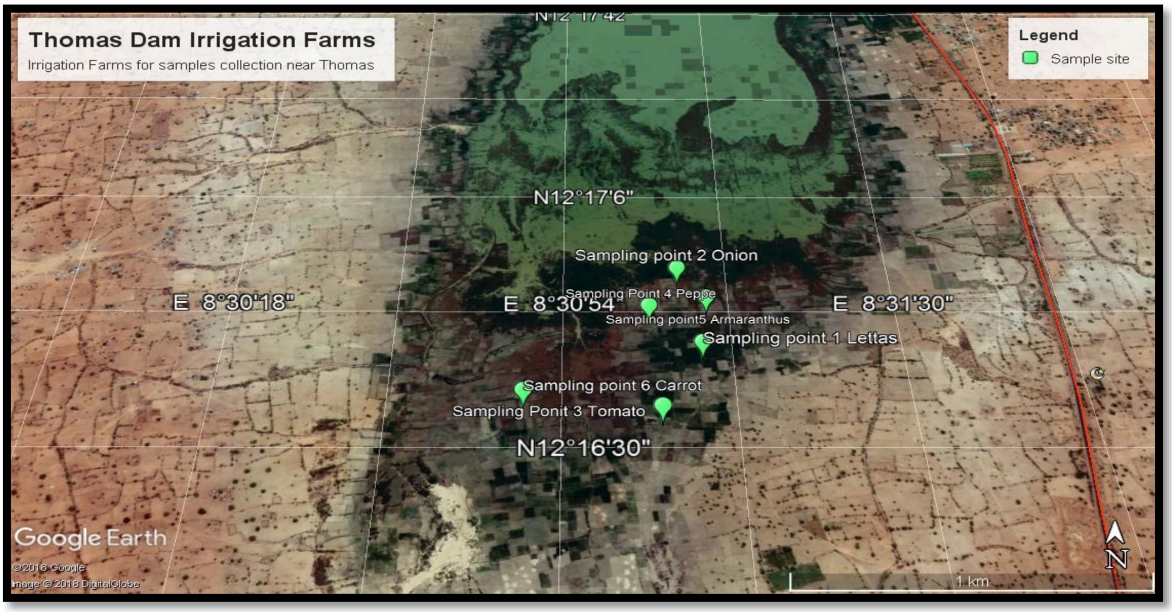

Figure 2. Map of Thomas Dam showing water irrigation farms (THDW)

Preparation of Sample:

Samples of vegetable (viz: tomato, onion, carrot, pepper fruit, lettuces and amaranthus) were freshly obtained from various irrigation farms and placed into large leveled polyethlylene sampling bag and transported to analytical laboratory at Bayero University, Kano for analysis. Vegetables were first washed in fresh running tap to remove dirt, soil sediments and other surface contaminants. The edible parts were then further washed with deionised water. The clean vegetables were cut into 2cm pieces, air dried and placed in an oven at 65°C for 72-96 hours in the laboratory. The dried samples were harmonized by grinding using ceramic coated grinder and kept for analyses (Naseer *et al*., 2012).

Wet Digestion and Analytical Procedures:

A mass of lg of air- dried plant sample was placed in a 100cm^3 conical flask and moistened with 4cm^3 deionised water, 5cm^3 concentrated sulphuric acid and 10cm^3 concentrated nitric acid were added. The flask was slightly heated to avoid splashing of the solution, decomposition and fuming away of the nitric acid. For incomplete oxidation of the organic substance, additional 5cm^3 nitric acid added and the solution was heated at a higher temperature (60-100 °C) for 10 minutes (Vazhenin 1974). After cooling, the solution was diluted with 10cm^3 deionised water and filtered with whatmann no. 42 fitter paper and the solution was made to 50cm^3 by adding deionised water. It was then transferred quantitatively to a capped screwed polyethylene plastic bottle.

The content of heavy metals in the filtrate was determined by micro plasma- atomic emission spectrophotometer (MP-AES Model 4210)

Blank:

A blank was prepared going through all steps of the procedure above with reagents only. The blank reading was also taken which corrects for any contamination in the reagents when analyzing the concentration of various elements. The method parameters for the analysis are given in Table .I:

Table I: MP-AES method parameters.

Parameter	**Values are results of three replicates**
Pump rate	15rpm
Sample uptake delay	35 seconds
Rinse time	30 seconds
Stabilization time	15 seconds
Fast pump during uptake and rinse	On (80rpm)

Sample Analysis

The heavy metals were analyzed from solutions of the metals by microwave – atomic emission spectrophotometers (MP-AES) at the Bayero University, Kano Center for Dry Land Agricultural Research Laboratory for all the elements in a single measurement.

Statistical Analysis

Data collected were analyzed using software JMP4 version 14 windows. The data were expressed in terms of descriptive statistics while the figures were presented with mean values of triplicates measurements. The data obtained were subjected to analysis of variance (ANOVA) to assess the effect of vegetable type and site of production on the concentrations of heavy metals contaminant in the vegetables tested (Table III and IV). As the level of heavy metal contamination might vary with sample collection site and vegetable type, ANOVA was used to test the existence of significant difference in heavy metal concentrations among the varieties of vegetables and between the sites. Mean values followed by different letters within columns are significantly different.

RESULTS AND DISCUSSIONS

Levels of Heavy Metals in Lettuce (*Lactuca Sativa*) sample

Figure 3. Shows the distribution of Lead in the lettuce sample with concentrations range from 1.93-8.39 mgkg^{-1}. Lead was detected in all the five sampling areas with the highest values of 8.39 mgkg^{-1} in SIWW sampling area. The present study revealed that the lead concentrations in the lettuce sample were above the (WHO/FAO 2007) stipulated limit of 0.3 mgkg^{-1}.

Similar studies conducted in Ghana reported concentration range of Pb with mean range of 5.59-10.51 mgkg^{-1} grown in long term wastewater irrigated urban farming sites in Accra (Lente 2012), however, the results obtained 0.58 mgkg^{-1} by (Radman and Salman, 2006) was comparatively low from Egypt (Table II). The consumption of lettuce loaded with heavy metals grown on contaminated soils has been found to pose health risk to consumers (Kachenko and Singh 2006). There was no significant difference in the mean content of Pb among the varieties of vegetables analyzed and no variation for the competition of the absorption of Pb in the five sampling sites. (Tables III and IV).

Chromium concentrations in lettuce samples ranges from 18.52-23.8 mgkg^{-1}. Excessive level of chromium were obtained in RCYW while the lowest level was obtained in THDW sampling site (Figure 3). Several studies have indicated that vegetable grown in heavy metals contaminated soil have higher concentrations of heavy metals than those grown in uncontaminated soils (Maleki and Zarasvand 2008; Dowdy and Larson 1975; Guttermsen *et al*., 1975)

Similar studies by Smilde *et al*., (1992) showed a decrease in the Cr concentration (3.0 and 13.4 mgkg^{-1}) due to irrigation with sewage sludge, which was lower than the values (18.52-23.80 mgkg^{-1}) obtained in this present study. In fact, there was no significant difference between the vegetables study in the mean content of heavy metals except for the chromium concentration 22.26a mgkg^{-1} and onion 16.87b mgkg^{-1} which shows the highest and lowest concentration in the vegetables (Table III). As the level of heavy metals concentration might vary with the sampling site, significant differences were observed between their means.

Levels of heavy metals in carrot (*Daucus carota*) sample

The results of this study showed that, *Daucus carota* collected from the five sampling sites; SIWW, KRWW, THDW, RCYW and RCIW had Lead concentrations in the range 0.71 to 4.38 mgkg^{-1} (Figure 4). This finding corroborates the characteristics of Lead of accumulating preferentially in the roots. The high Lead concentration in roots also can be related to the immobilization of this element by insoluble organic polymers present in the root tissue (Kahle, 1993). In an analogous study, a similar result (4.89 mgkg^{-1}) was obtained by Oyekanmi *et al*., (2018), also from Nigeria (Table II). There was no significant difference in the Lead (Pb) concentration in carrot among the varieties of vegetabes analyzed. All the vegetables were affected by the high concentration of Pb from the five sampling sites. (Table III and IV).

Higher concentrations of chromium in carrot samples were detected (24.13, 22.72, 17.39, 12.46) mgkg^{-1} in RCIW, RCYW, KRWW and SIWW sampling sites respectively, (Figure 4). A lower concentration of 11.83 mgkg^{-1}from THDW sampling site was also detected. The carrots from these four sampling sites were more contaminated than the samples from THDW irrigation farmlands. The result of these study areas were higher than the chromium concentration (8.05 mgkg^{-1}) reported by (Prabu 2009), from Ethiopia (Table II). These variations might be due to pollutants in the irrigation water, atmospheric deposition and soil type differences in the metal accumulation.

There was no significant difference in the mean content of Cr in carrot among the varieties of vegetables analyzed, also the sampling sites has no significant effect in the accumulation of the metal by the vegetables (Table III and IV).

Levels of Pb and Cr in pepper fruit (*Capsicum annum*) sample

The highest Lead concentration of 4.16 mgkg^{-1} in pepper sample was observed in SIWW, RCYW has a concentration of 2.98 mgkg^{-1} followed by KRWS with a concentration of 2.39 mgkg^{-1} while THDW sampling site has the least concentration of 0.77 mgkg^{-1} (Figure 5). A comparable Pb concentration (2.65 mgkg^{-1}) with RCYW and KRWW sampling sites was reported by (Suruchi and Jilani 2011), from China. There was no significant difference in the mean content of Lead concentration among the varieties of the vegetables analyzed as well as in all the sampling sites (Figure 5). Lead forms and contents in the vegetables vary greatly with species and depend principally on the environmental conditions because contaminated soils can induce lead accumulation by crops (Nan *et al* 2002).

The level of chromium in the sample of pepper from SIWS and KRWS have nearly the same concentrations of 18.18 and 18.05 mgkg^{-1}respectively, while the highest mean concentration of 20.94 mgkg^{-1} was obtained in RCIW sampling area (Figure.5).Similarly, RCYW sampling area has a concentration of 19.31 mgkg^{-1}, however the least concentration was obtained from Thomas Dam irrigation farmlands. Therefore, the high concentrations in RCIW, RCYW, SIWW and KRWW could be attributed to increase tannery processes discharging their waste in the area (Cynthia *et al.*, 2012)**.**

The result from this study was almost similar to the results (6.0-23.2mgkg) obtained by (Mapanda *et al.*, 2005), from India (Table II), but it is higher than the results (4.63-9.28 mgkg^{-1}) of the previous studies by (Oyekanmi *et al*., 2018), from Nigeria (Table II). There was no significant difference in the mean content of chromium in pepper samples, however there was low level of accumulation by the sample in KRWW and THDW sampling sites (Table IV). Due to the fact that industrial waste water which contains chromium as the most prevalent was not used for irrigation in the sampling area.

Levels of Pb and Cr in Tomato (*Lycopersium esculentum*) Sample

Tomato samples from KRWS sampling site recorded the highest concentration of Pb followed by RCIW and SIWW whilst RCYW and THDW recorded the least concentration of Lead (Fig.6).

The concentrations of Lead in the analyzed samples ranged (0.71-4.8 mgkg^{-1}) (Figure 4) in this study is lower than the value (13.97 mgkg^{-1}) obtained by (Oyekanmi *et al*., 2018), in Nigeria. But higher concentrations of Lead 13.0-29.0 mgkg^{-1} were recorded by (Sharma *et al.*, 2006), from India, while very low level of lead were obtained by (Radman and Salman, 2006) from Egypt (Table II).

There was no significant difference in the mean content of Pb in the six tested vegetables and the irrigation sites.

The distribution pattern for chromium in tomato samples analyzed from the different study areas shows the scenario of the metal in its ability to accumulate (RCYW 25.90, KRWW 24.72, RCIW 18.16, THDW 16.97 and SIWW 16.34) mgkg^{-1}(Figure 6). However, the maximum permissible limit of chromium in food is (2.3 mgkg^{-1}), (FAO/WHO 2003). Therefore, the vegetable can provide more than the required concentrations, hence may result in toxic effects. The results of this study were also higher than the results of (Prabu 2009).

Several studies have indicated vegetables grown in heavy metals contaminated soils have higher concentrations of heavy metals than those grown in uncontaminated soils (Dowdy and Larson, 1975; Prabu 2010).

There was no significant difference in the mean concentration of chromium among the varieties of vegetables analyzed, however there was low and high chromium accumulation in the tomato samples from THDW and RCYW sampling site, (Table III and IV).

Levels of Pb and Cr in amaranthus (*Amaranthus tricolor*) sample

The sample of Amaranthus under investigation in this research work contained the level of Lead in the range 2.05 to 7.93 mgkg^{-1}, (Figure 7). Highest concentration was obtained in RCIW and lowest in SIWW sampling sites. In a similar study (Atayese *et al.*, 2009), reported a concentration of Lead in amaranthus leaves ranged from 68 to 152 mgkg^{-1}. The results of this study reveals that the content of Lead Pb in amaranthus are higher than the acceptable safe limit for the body. The elevated level of Pb may lead to the Pb toxicity and potential health hazards to consumers.

There was significant difference among the varieties of vegetables analyzed, however, there appeared no site effect in the accumulation of Pb; hence there was no variation in the uptake of Pb by the amaranthus samples in the sampling sites

Samples from KRWS have accumulated the highest value of the chromium concentration of 22.81 mgkg^{-1} in the amaranthus tricolor samples, 20.98 mgkg^{-1} was obtained from RCYW area, while 18.59 mgkg^{-1}was from SIWW sampling area. Concentrations in RCIW were observed to be 17.18 mgkg^{-1} and the sample from THDW contained the least concentration of 16.33 mgkg^{-1} (Figure 7). For crop protection use of industrial wastewater particularly in RCYW and SIWW irrigation farmlands has resulted in the high accumulation of chromium metals in the samples, which is a health hazard to human beings (Smith *et al*., 1996).

The level of Cr varied between the vegetable varieties from site to site, but there was also significant difference in the level of Cr between the vegetables.

Level of Pb and Cr in onion (*Allium cepa*) sample

The concentration of Lead in onion bulb were varied from 0.99 mgkg^{-1} to 3.26 mgkg^{-1} (Figure 8). The highest lead content was found in THDW sampling area. It was found that from figure 8, onion bulb contain Lead concentration more than the permitted concentration level, so they are not suitable for human consumption (WHO/FAO 2007; FAO 1998**).** The most probable reason could be farmlands near to the road. Lead toxicity is known to cause musculo-skeletal, renal, ocular, neurological, immunological, reproductive and developmental effects (Embedkar and Muniyan, 2012).

There was no significant difference in the mean content of onion among the varieties of six tested vegetables and the sampling sites. The Lead content in this study; is as a result of human activities such as wastewater irrigation, solid waste disposals, agrochemicals and vehicular exhaust particularly where the farmlands are situated near to the main roads. In another study Noor-Al-Amin, (2013) reported a Lead (Pb) content of 13.50 mgkg^{-1} in *A. Cepa*. These concentrations were not only greater than the highest concentration of 3.26 mgkg^{-1} obtained from THDW sampling site but was also several folds higher than the safe limits (0.3 mgkg^{-1}) recommended by WHO/FAO (2007).

The pattern of the chromium concentrations in the different sampling areas was in the order RCIS 22.14 mgkg^{-1}> THDW 18.66 mgkg^{-1}> KRWW 17.37 mgkg^{-1}> SIWW 16.62 mgkg^{-1}> RCYW 9.58 mgkg^{-1} (Figure 8). These values are above the maximum permissible limits of 2.3 mgkg^{-1} by FAO/WHO (2007). Therefore, the study showed that the chromium contents have exceeded the permissible limits. From these results there was no significant difference among the vegetables except for the chromium content in onion (16.87b mgkg^{-1}). However, there are some variations in the level of chromium accumulated by the vegetables from the sampling sites. The highest level of chromium was recorded in RCYW (21.13a mgkg^{-1}). It was 2.8% higher than the chromium level in RCIW (20.54ab mgkg^{-1}) and 2.4% higher than of RCYW (20.06ab mgkg^{-1}), while a lower concentration of chromium was obtained in SIWW and a least passage of chromium 16.29b mgkg^{-1} was obtained in THDW sampling area.

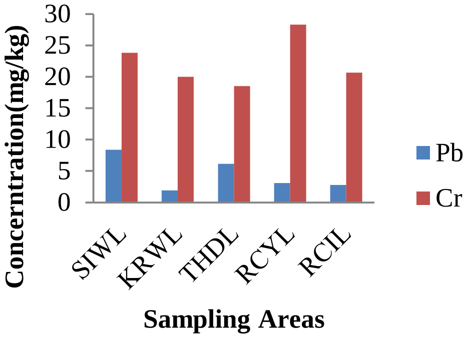

Figure 3: Mean Concentration of the metals analyzed in lettuce Sample from different sampling areas.
Key:
SIWL: Sharada Industrial Waste water lettuce
KRWL: Kano River Well-water Lettuce
THDL: Thomas Dam Water Lettuce
RCYL: River Challawa-Yandanko Lettuce
RCIL: River Challawa-Industrial Waste Water Lettuce

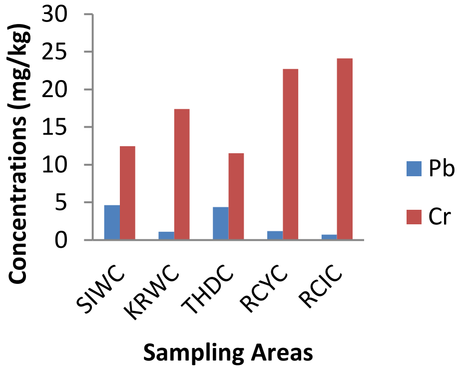

Figure 4: Mean Concentration of the metals analyzed in Carrot Sample from different sampling areas.
Key:
SIWC: Sharada Industrial Waste water Carrot
KRWC: Kano River Well-water Carrot
THDC: Thomas Dam Water Carrot
RCYC: River Challawa-Yandanko Carrot
RCIC: River Challawa-Industrial Waste Water Carrot

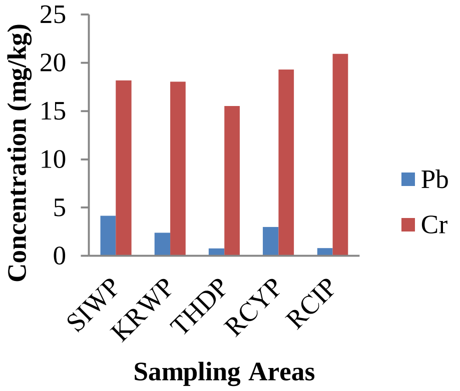

Figure 5: Mean Concentration of the metals analyzed in Pepper Sample from different sampling areas.
Key:
SIWP: Sharada Industrial Waste water Pepper
KRWP: Kano River Well-water Pepper
THDP: Thomas Dam Water Pepper
RCYP: River Challawa-Yandanko Pepper
RCIP: River Challawa-Industrial Waste Water Pepper

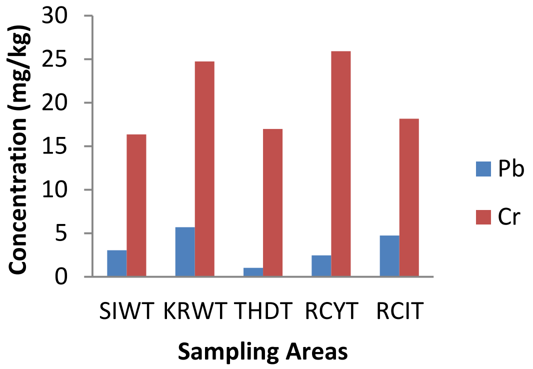

Figure 6: Mean Concentration of the metals analyzed in Tomato Sample from different sampling areas.
Key:
SIWT: Sharada Industrial Waste water Tomato
KRWT: Kano River Well-water Tomato
THDT: Thomas Dam Water Tomato
RCYT: River Challawa-Yandanko Tomato
RCIT: River Challawa-Industrial Waste Water Tomato

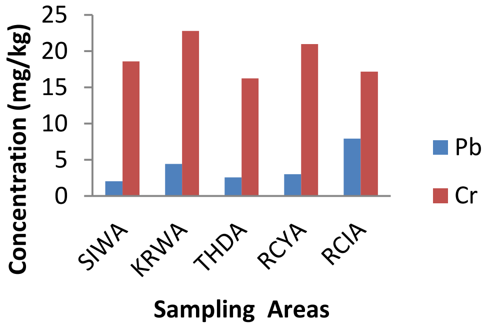

Figure 7: Mean Concentration of the metals analyzed in Amaranthus Sample from different sampling areas.
Key:
SIWA: Sharada Industrial Waste water Amaranthus
KRWA: Kano River Well-water Amaranthus
THDA: Thomas Dam Water Amaranthus
RCYA: River Challawa-YandankoAmaranthus
RCIA: River Challawa-Industrial Waste Water Amaranthus

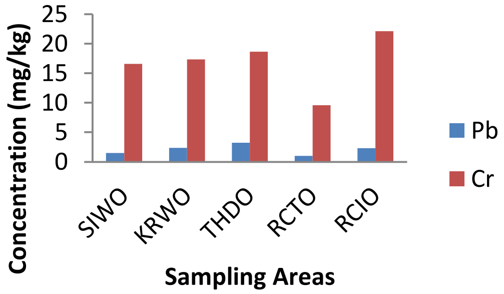

Figure 8: Mean Concentration of the metals analyzed in Onion Sample from differentsampling areas.
Key:
SIWO: Sharada Industrial Waste water Onion
KRWO: Kano River Well-water Onion
THDO: Thomas Dam Water Onion
RCYO: River Challawa-Yandanko Onion
RCIO: River Challawa-Industrial Waste Water Onion

Table II: Comparison of the average concentrations of metals in this study with literature and WHO (2007) values.

Methods	Types of vegetables	Heavy Metal Concentration		Country
		Pb	**Cr**	
AAS {Sharma *et al*., 2006)	Amaranthus	(12.50-27.00)	(6.00-23.20)	India
	Tomato	(13.00-29.00)	(4.00-9.80)	
AAS (Prabu, 2009)	Carrot		8.05	Ethopia
	Onion		8.58	Akaki
	Tomto		4.91	River
	Pepper		5.55	
	Lettuce		24.11	
MP-AES	Lettuce	2.79-8.39	20-23.8	This study
	Carrot	0.71-4.38	11.83-24.13	
	Pepper	0.77-4.16	15.52-2094	
	Tomato	1.00-5.69	16.34-25.9	
	Amaranthus	2.05-7.93	16.23-22.81	
	Onion	0.99-3.26	9.58-22.14	
MP-AES Oyekanmi	Tomato	13.97	4.63	Nigeria
	Lettuce	4.89	9.28	
AAS Radman& Salman 2006	Lettuce	0.58		Egypt
	Tomato	0.01		
	Vegetable	0.3	2.3	(WHO) permissible level

Table III: Statistical summary of the Effect of vegetable crops factors on Pb and Cr metals accumulation.

Crop	Pb	Cr
Onion	2.08a	16.87b
Lettuce	4.47a	22.26a
Carrot	2.40a	17.71ab
Pepper	2.22a	18.40ab
Tomato	3.38a	20.42ab
Armarantus	4.0a	19.11ab
SE±	0.91	1.73

Values followed by different letters within columns are significantly different.

Table IV: Statistical summary of the Effect of site factors on Pb and Cr metals contents (mgkg^{-1}) of six tested vegetables

Site	Pb	Cr
Kano River Well water (KRWW)	2.99a	0.06ab
Sharada Industrial Waste water (SIWW)	3.96a	17.67ab
River Challawa– Yandanko Well water (RCYW)	2.29a	21.13a
River Challawa Industrial Waste water (RCIW)	3.22a	20.54ab
Thomas Dam Water (THDW)	3.02a	16.29b

CONCLUSION

Heavy metals are not only affecting the nutritive values of vegetable but also have deleterious effect on human beings using these food items. Determination of heavy metals concentration in vegetable and food products is important for health risk assessment. This study revealed that, maximum regulated level of Pb and Cr were over stepped in all the vegetable samples and these high values may be attributed to atmospheric pollution, industrial effluent and pollution associated with sewage sludge and municipal wastes. Also, the study revealed that the vegetables, (carrot, tomato and onion) accumulate the highest concentration of these toxic metals. Accordingly, increased concentrations of Pb and Cr in the vegetable samples analyzed were also been detected in comparable studies by other workers (Oyekanmi 2018; Prabu 2009; Ayetese 2009; Odai 2008; Adeniyi1996). The accumulations of heavy metals among the varieties of vegetables and their interaction effect in the sites were interpreted using ANOVA. The result of ANOVA indicated that there were no significant differences in the levels of most metals between the six samples in the five sampling sites. Generally, the levels of metals significantly differed between the five sampling sites due to variation in the soil type and source of water used for the irrigation. Therefore, the consumption of foods contaminated with heavy metals may result in long-term low-level body accumulation of these elements and the detrimental impacts will become apparent only after several years of exposure.

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