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Research Article

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Assessment of chromium concentrations in wastewater, soil and vegetable samples grown along Kubanni stream channels in Zaria, Kaduna State, Nigeria

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ABSTRACT

The concentration of chromium was determined in wastewater, soil and vegetable (carrot, lettuce, onion, spinach, cabbage, tomato and okro) samples collected on seasonal basis from January, 2013 to September 2014 along Kubanni stream channels in Zaria. The results showed chromium levels in wastewater were in the range of 4.17 – 33.33 mg/L for the year 2013 and 2.74 – 37.15 mg/L in 2014; 3.25 – 17.35 mg/Kg for the year 2013 and 3.75 – 18.40 mg/Kg in 2014 for the soil while the vegetables had concentrations in the range of 3.15 – 16.67 mg/Kg for the year 2013 and 1.58 – 24.32 mg/Kg in 2014. Statistical analysis revealed no significant difference in chromium levels across the locations and seasons for wastewater, soil and vegetables analyzed while significant difference ($p < 0.050$) was observed across the sampling location for soil. Pearson correlation showed substantial ($r = 0.724$) relationship between chromium levels in wastewater for the year 2013 and 2014, moderate ($r = 0.671$) relationship for soils between these two years while negative ($r = -0.076$) relationship was obtained for vegetables cultivated in 2013 and that of 2014 respectively. Chromium concentrations obtained in this study was higher than Maximum Contaminant Levels set by Standard Organizations such as W.H.O. and F.A.O.

Keywords: Chromium level, Kubanni River, Soil, Vegetable and Wastewater.

INTRODUCTION

Chromium is a transition metal with atomic number 24 and chemical symbol Cr. It is an important element for the insulin activity and DNA transcription. However, an intake below 0.02 mg per day could reduce cellular responses to insulin [1]. Chromium in its hexavalent form is the most toxic species of chromium which is extensively used in leather processing. As a result, chromium has become a major factory run-off pollutant that is beginning to become a global trend [2]. The toxicity of chromium arises from its tendency to be corrosive and to cause allergic reactions. It is widely distributed in the earth's crust and exists in oxidation states of +2 and +6 [3]. Chromium and its salts are used in the leather tanning industry, the manufacture of catalysts, pigments and paints, fungicides, the ceramic and glass industry and in photography. It is also used for chromealloy, chromium metal production, chrome plating, corrosion control, colouring agents for emerald green glass, chemical analysis, textile colour pigments and mordants and trace minerals essential to the nutrition of man and animals [4]. Chromium functions in mammalian glucose metabolism and appears to be essential to man and animals [5].

Modern agriculture is becoming nuisance to mankind. The insecticides, pesticides, chemical fertilizers especially nitrate and phosphate are used annually to boost agricultural production and these chemicals are leached down to the soil and eventually end up to contaminate the ground water and stream waterways and River Kubanni is equally surrounded by these types of activities which are likely to pollute the waterway [6]. The major causes of water pollution in most countries of the tropics can be linked to human activities such as sewage and refuse disposal, industrial effluents, agricultural activities, mining and quarrying activities [7]. The most common source of water pollution in developing nations is domestic sewage and refuse. [8]is of the opinion that several chemical elements including chromium have their origin in the composing high refuse dumps that is similar to pollution pattern in the catchment area of Kubanni River. Several other studies have shown that a considerable number of elements are leached from refuse dumps during rainy season into ground water and stream [9].

Study Area

Zaria city is in northern Nigeria on longitude 7˚42˙E and latitude 11˚03˙N, within the drainage of River Kubanni flowing to the south east direction through Ahmadu Bello University. The vegetation of the area is the savannah type with more grasses than hard wood trees. The average annual rainfall is 875mm and the temperature varies between 27 to 35˚C with a relative humidity [10]. The geology of the study area is composed mainly of fine grain gneisses and migmatite with some coarse-grained granitic outcrops in few places. The soil of the study area is mainly sandy-clay loam with poor infiltration because of the high clay content [11]. The entire vegetation and soils of the study area have been under great anthropogenic influences which have greatly modified the entire landscape [12]. Kubanni River is known for its human activities like farming, source of drinking water, washing and fishing. Some peasant farmers use its bank for farming throughout the year especially Sabon-gari area, here there is planting of vegetables of different varieties. This necessitates irrigated farming system to meet up with the demand for vegetables and promotes the use of wastewater, herbicides, fungicides, pesticides and fertilizers which are sources of pollutants (chromium) [1]. High population of the area coupled with the amount of waste that is indiscriminately discharged into the body of Kubanni River makes it prone for contamination which necessitates the study on the nature of vegetables consumed by people from the area. This study is aimed at ascertaining the extent to which chromium is accumulated in wastewater, soil and vegetables through man-made activities**.**

EXPERIMENTAL SECTION

Sampling

Wastewater samples from Kubanni stream were obtained from five different sampling points on a four month basis along the stream channels for the period of two years. Sampling was conducted in the harmattan, dry and rainy seasons. Wastewater samples were collected using composite sampling in a polyethylene plastic containers that were previously cleaned by washing in non-ionic detergent and then rinsed with tap water and soaked in 10% HNO_3 for 24 hours and finally rinsed with deionized water prior to usage [7]. During sampling, sample bottles used were rinsed with sampled water three times and then filled to the brim at a depth of one meterbelow the wastewater from each of the five designated sampling points. Wastewater sample bottles were labelled, stored in ice-blocked coolers and transported to the laboratory while in the laboratory, they were stored in the refrigerator at about 4 °C prior to the analysis [13]. Soil samples were collected at three depths (0-5 cm, 5-10 cm and 10-15 cm) from both side of the river banks by using spiral auger of 2.5 cm diameter. Soil samples were randomly sampled and bulked together to form a composite sample from each designated point. They were then put in clean plastic bags, labelled and transported to the laboratory. The full grown vegetable of [spinach (*Amaranthus hybridus*), lettuce (*Lactuca sativa*), cabbage *(Brassicaoleracea*), carrot (*Daucus carota*), okro (*Hibiscus esculentus*), onion (*Allium cepa*) and tomato (*Lycopersicon esculenetum*)] were randomly handpicked from various garden plots along Kubanni stream channels using hand gloves, bulked together to form a composite sample, wrapped in big brown envelopes, labeled accordingly and transported to the laboratory.

Sample Treatment

Wastewaters used for chromium determinations were acidified at the points of sampling with $5cm^3$ of concentrated HNO_3 as to avoid microbial activities on the wastewaters which might reduce the concentrations of intended chromium before analysis and they were kept in a refrigerator prior to analysis [13]. Soil samples were air-dried, crushed and passed through 2 mm mesh sieve. The soil samples were then put in clean plastic bags, sealed and labelled accordingly. Each vegetable samples were washed with tap water, followed by deionized water, air dried in the laboratory, grounded to powder and sieved using 250 µm sieve [14].

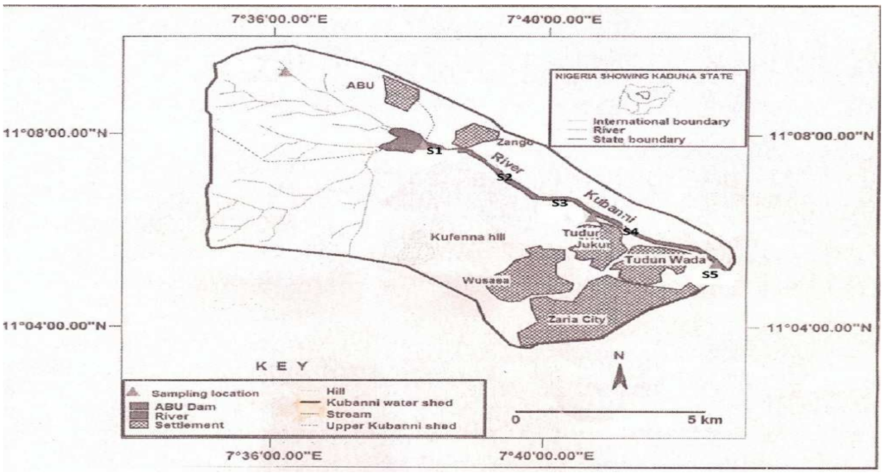

Figure 1:- Map of Sampling Locations

Digestion of Wastewater Samples for Chromium Determination

1000 cm^3 of each wastewater sample was transferred into a beaker and 50 cm^3 concentrated HNO_3 was added. The beaker with the content was placed on a sand bath and evaporated down to about 20 cm^3 and this was analyzed as described by [7]. Cr was determined at 358 nm wavelengths using Alpha-4 Model AAS [15].

Determination of Chromium in Soil Samples

Two grams of each soil sample was weighed into acid-washed glass beakers. Soil samples were digested by the addition of 20 cm^3 of aqua-regia (mixture of HCl and HNO_3 in ratio 3:1) to each soil sample and 10 cm^3 of 30 % H_2O_2 were added in small portion to avoid any possible overflow leading to loss of material from the beaker. The beakers were covered with the watch glasses and heated on a water bath for 2 hours at 90 ºC. The beakers wall and watch-glasses were washed with deionized water and the samples were filtered out to separate the insoluble solid from the supernatant liquid. Soil samples volume was made up to 100 cm^3 by adding deionized water to the mark levels. It was then analyzed for Cr at 358 nm wavelengths using Alpha-4 Model Atomic Absorption Spectrophotometer (AAS) [15].

Digestion of Vegetable Samples for Chromium Determination

Three grams of the dry sample of each vegetable sample was ashed using Muffle furnace set at 450 °C on cooling, the ash was transferred to a decomposition flasks and 1cm^3 of concentrated HNO_3 was added and then analyzed as described by [15].

RESULTS AND DISCUSSION

The results of chromium in wastewater and vegetables analyzed were expressed in form of bar-charts using Microsoft Excel (Window 7 Professional), the results obtained were subjected to one way Analysis of Variances (ANOVA) and Pearson Product Moment Correlations (PPMC) using Statistical Package for the Social Sciences (SPSS) 20.0 version software. Null hypothesis was adopted and this was set at 95% Confidence Mean level to check if there is significant difference in the concentrations of chromium analyzed. Statistical decision for Pearson Correlation Coefficients (r) were taken as follows;

(1) If $0.05 \leq r \leq 0.20$ there is negligible relationship
(2) If $0.21 \leq r \leq 0.40$ there is low relationship
(3) If $0.41 \leq r \leq 0.60$ there is moderate relationship
(4) If $0.61 \leq r \leq 0.80$ there is substantial relationship
(5) If $0.81 \leq r \leq 1.00$ there is very high relationship [16]

Figure 2 presents chromium concentrations in wastewater from Kubanni stream channels. The concentrations determined were in the range of 4.17 – 33.33 mg/L for the year 2013. Highest level was found at Unguwa-fulani (33.33 mg/L) during harmattan season followed by 32.07 mg/L from the same sampling site but in the dry season.

High levels were also noticed at Industrial area along Jos road (29.0 mg/L), Sabon-gari (28.54 mg/L) both in the dry season whereas the least concentration of 4.71 mg/L was obtained at Sabon-gari in the rainy season. Chromium level in harmattan season (16.67 – 33.33 mg/L) did not differ much to that of dry season (18.57 – 32.07 mg/L) while rainy season showed least concentration of chromium (4.17 – 16.60 mg/L). Elevated level of chromium during harmattan and dry seasons might be as a result of continuous deposition of dusts during the harmattan season coupled with less dilution effect of rainfall as suggested by [17] and [18]. In 2014, concentrations determined for chromium in wastewater were in the range of 2.74 – 37.15 mg/L. Highest level was observed at Sabon-gari (37.15 mg/L) during harmattan season followed by 29.67 mg/L from Industrial-area along Jos road in the same season. High levels of chromium were also found at Unguwa-fulani (27.15 mg/L) during harmattan season, the level of chromium at Tundun-wada was 27.09 mg/L, Unguwa-fulani had 25.40 mg/L and while Kwangila had chromium level as 23.18 mg/L, all these results were obtained in the dry season. High levels of chromium from all the sampling sites could be attributed to various tannery industries located in the industrial areas and this results to the discharge of their industrial wastes into River Kubanni as reported by [12] and [19]. Comparing the results obtained in the year 2013 to that of 2014, it can be revealed from the bar-chart that chromium level in rainy season 2013 (4.17 – 16.60 mg/L) was higher in concentrations than rainy season 2014 (2.74 – 5.33 mg/L) whereas harmattan season 2014 (12.05 – 37.15 mg/L) showed high level of chromium than that of harmattan season 2013 (16.07 – 33.33 mg/L). There was gradual build-up in chromium levels in 2014 which might be due to high production of wastes from tannery/leather industries as their wastes are rich in chromium according to [4]. Chromium levels in this study was above permissible limit set by [20] (0.55 mg/L) and this indicates that the wastewater used for farming in the sampling locations are polluted with chromium metal. [21] reported 84.5 mg/L as chromium level in wastewater from irrigated garden which was above the results obtained in this study whereas reported concentrations by [22] (4.33 – 19.15 mg/L) and [23] (3.87 – 7.87 mg/L) were less than results obtained in this present study.

Figure 3 presents chromium concentrations in soil from Kubanni stream channels. The concentrations determined were in the range of 3.25 – 17.35 mg/Kg for the year 2013. Least level was found at Kwangila sampling site (3.25 mg/Kg) in the dry season while highest concentration of 17.35 mg/Kg was recorded at Sabon-gari during the dry season. High levels were also noticed at Tundun-wada (16.67 mg/Kg) during harmattan season, Industrial area along Jos road (13.82 mg/Kg) during harmattan season and 13.67mg/Kg at the same site but in the dry season. Kwangila and Unguwa-fulani sampling sites showed low level of chromium in the year with concentrations in the range of 4.17 – 4.18 mg/Kg for the former while 4.25 – 4.60 mg/Kg for the latter.

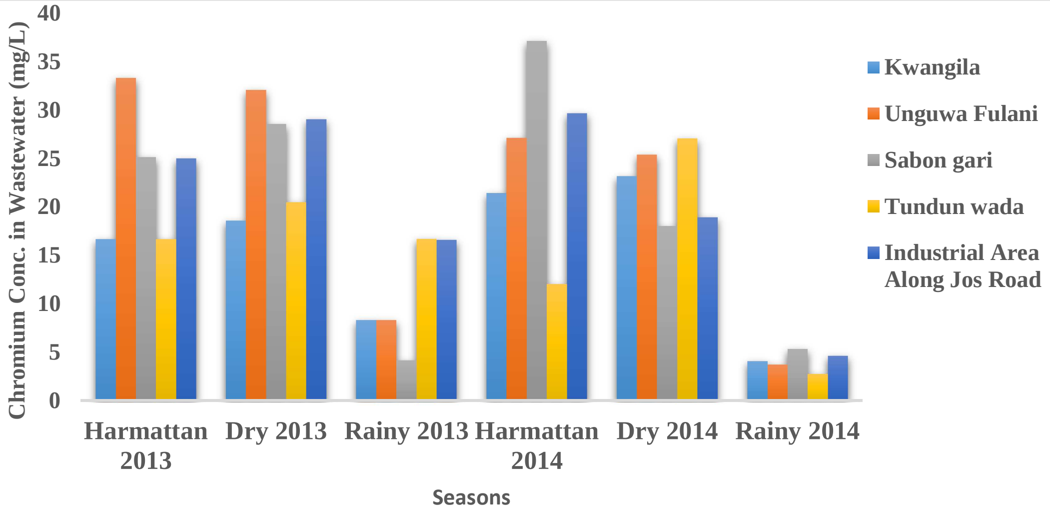

Fig. 2: Chromium Concentrations in Wastewater from Kubanni stream Channels, Zaria

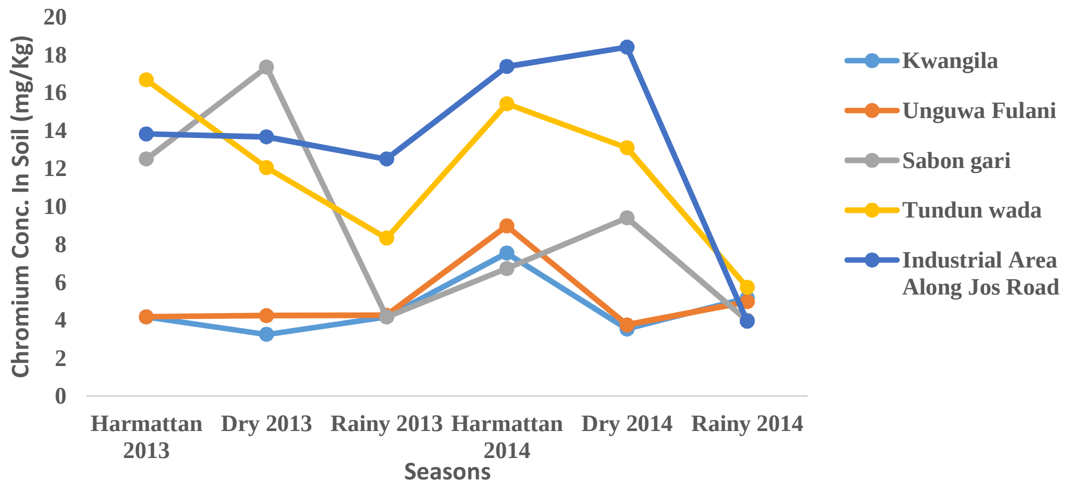

Fig. 3 : Chromium Concentrations in Soil from Kubanni Stream Channels, Zaria

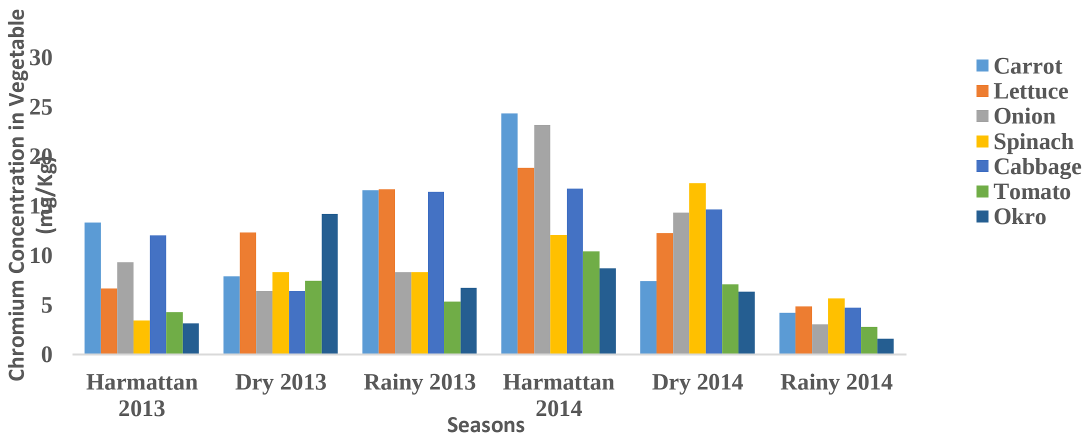

Fig. 4: Chromium Levels in Vegetables from Kubanni Stream Channels, Zaria

Low concentrations of chromium at these sites might be as a result of dissolution of industrial effluents from tannery factories and farness of these sites to the community as suggested by [22]. Chromium had concentrations in the range of 3.75 – 18.40 mg/Kg for the year 2014. Highest level was found at Industrial area along Jos road (18.40 mg/Kg) during the dry season and closely followed by 17.38 mg/Kg from the same sampling site but in the harmattan season. High levels were also noticed from Tundun-wada (15.42 mg/Kg) during the harmattan season and 13.09 mg/Kg in the same location but in the dry season. Sabon-gari sampling site (9.40 mg/Kg) showed high level of chromium in the dry season and closely followed by 8.97 mg/Kg from Unguwa-fulani during the harmattan season. Least concentration of 3.94 mg/Kg during rainy season was obtained at Kwangila sampling site. Low levels of chromium was recorded in the rainy season of 2014 with concentrations in the range of 3.94 – 5.74 mg/Kg. This might be related to dilution effect as suggested by [18]. Comparing the results obtained for the year 2013 and 2014, rainy season of 2013 (4.17 – 12.50 mg/Kg) had high concentration of chromium than rainy season of 2014 (3.94 – 5.74 mg/Kg) whereas harmattan season of 2013(4.18 – 16.67 mg/Kg) showed low level of chromium when compared with harmattan season of 2014 (6.73 – 17.38 mg/Kg). Kwangila sampling site (3.25 – 7.54 mg/Kg) had least level of chromium while Industrial area along Jos road (3.94 – 18.40 mg/Kg) showed highest accumulation. This might be connected to closeness/farness of these sampling sites to tannery effluents as suggested by [1]. [20]reported 100 mg/Kg as maximum allowable limit for chromium in soil which was above the concentrations obtained in this study. The chromium levels analyzed were less to the concentrations reported by other workers including; [24] (1.80 – 72. 01 mg/Kg) and [25] (51.00 mg/Kg).

Chromium levels in vegetables analyzed from Kubanni stream channels is presented in figure 4. The concentrations determined were in the range of 3.15 – 16.67 mg/Kg for the year 2013. Highest level was noticed in lettuce (16.67 mg/Kg) followed by carrot (16.60 mg/Kg) and closely followed by cabbage (16.40 mg/Kg) all these results were obtained in the rainy season. High concentrations were also observed in okro (14.20 mg/Kg), lettuce (12.32 mg/Kg) showed highest level both in the dry season, carrot (13.33 mg/Kg) and cabbage (12.04 mg/Kg) both in the harmattan season while the least level of chromium was recorded in okro (3.15 mg/Kg) during harmattan season. Spinach had moderate level of chromium as it showed concentration in the range of 3.45 – 8.33 mg/Kg. High levels of chromium among vegetables analyzed might be linked to tannery industries around the sampling sites as their effluents are rich in chromium metal according to [4]. This could also be as a result of excessive application of manure and superphosphate fertilizers as these could elevate the chromium levels as suggested by [26]. Vegetables analyzed had concentrations in the range of 1.58 – 24.32 mg/Kg for the year 2014. Highest level was noticed in carrot (24.32 mg/Kg) closely followed by 23.20 mg/Kg in onion and followed by 18.87 mg/Kg in lettuce all in harmattan season. High levels were also observed in spinach (17.32 mg/Kg) during dry season, cabbage (16.74 mg/Kg) in harmattan season whereas low concentrations were recorded in onion (3.04 mg/Kg), tomato (2.77 mg/Kg) and okro (1.58 mg/Kg) all these were obtained in the rainy season. There was steady decrease in chromium concentrations from harmattan season (8.68 – 24.32 mg/Kg) to rainy season (1.58 – 5.68 mg/Kg) in the year 2014. This could be as a result of flooding in 2013 that led to heavy erosion, this necessitated the application of more chemicals like herbicides, fungicides, pesticides and fertilizers than usual in the following year. Comparing results obtained in 2013 with that of 2014, there was remarkable increase in chromium levels from harmattan season 2013 (3.15 – 13.33 mg/Kg) to harmattan season 2014 (8.68 – 24.32 mg/Kg). This could be related to harmattan-dusts coupled with excessive use of wastewaters for irrigation as suggested by [22]. Likewise, there was increase in chromium level from dry season 2013 (6.40 – 14.20 mg/Kg) to dry season 2014 (7.40 – 17.32 mg/Kg). However, there was significant reduction in chromium levels from rainy season 2013 (5.34 – 16.67 mg/Kg) to rainy 2014 (1.58 – 5.68 mg/Kg). Throughout the period of sampling, carrot (4.20 – 24.32 mg/Kg) accumulated chromium metal most while tomato (2.77 – 10.43 mg/Kg) and okro (1.58 – 6.74 mg/Kg) showed the least levels of accumulation. [27] recommends 0.10 mg/Kg as maximum allowable limit for chromium in vegetable and this indicates that these vegetables are contaminated with chromium metal as the wastewater of the sampling sites revealed. The chromium levels analyzed were similar to concentrations obtained by other workers including; [25] (33.01±4.24 mg/Kg) in *Solanum macrocarpum* vegetable and [28] as they reported 22.68 mg/Kg in spinach, 34.48 mg/Kg in coriander and 8.74 mg/Kg in cauliflower.

Table 1:- Analysis of Variance for Chromium in Wastewater (Locations and Seasons)

Analysis of Variance		Sum of Square	df	Mean Square	F	Signif.
Chromium in Wastewater (Locations)	Between Groups	193.333	4	48.333	0.444	0.776
	Within Groups	2721.127	25	108.845		
Total		2914.460	29			
Chromium in Wastewater (Seasons)	Between Groups	127.581	5	25.516	0.220	0.951
	Within Groups	2786.879	24	116.120		
Total		2914.460	29			

Table 2:-Summary of Pearson Product Moment Correlation for Chromium in Wastewater

Variables	*N*	$\bar{x}$	SD	r	df	Signif.
Chromium 2013	15	19.971	8.865	0.724	13	0.002
Chromium 2014	15	17.371	11.224			

Table 3:- Analysis of Variance for Chromium in Soil (Locations and Seasons)

Analysis of Variance		Sum of Square	df	Mean Square	F	Signif.
Chromium in Soil (Locations)	Between Groups	365.492	4	91.373	5.923	0.002
	Within Groups	385.646	25	15.426		
	Total	751.139	29			
Chromium in Soil (Seasons)	Between Groups	49.438	5	9.888	0.338	0.885
	Within Groups	701.700	24	29.238		
	Total	751.139	29			

Table 4:-Summary of Pearson Product Moment Correlation for Chromium in Soil

Variables	*N*	$\bar{x}$	SD	r	df	Signif.
Chromium 2013	15	9.022	5.204	0.671	13	0.006
Chromium 2014	15	8.536	5.143			

Table 5:- Analysis of Variance for Chromium in Vegetables (Varieties and Locations)

Analysis of Variance		Sum of Square	df	Mean Square	F	Signif.
Chromium in Vegetable (Among various vegetable)	Between Groups	228.592	6	38.099	1.252	0.305
	Within Groups	1065.399	35	30.440		
	Total	1293.990	41			
Chromium in Vegetable (Seasons)	Between Groups	23.392	5	4.678	0.133	0.984
	Within Groups	1270.599	36	35.294		
	Total	1293.990	41			

Table 6:-Summary of Pearson Product Moment Correlation for Chromium in Vegetables

Variables	*N*	$\bar{x}$	SD	r	df	Signif.
Chromium 2013	21	9.218	4.282	- 0.076	19	0.743
Chromium 2014	21	10.501	6.745			

Table 1 presents Analysis of Variance for chromium levels in wastewater as it shows, $p = 0.776 > 0.050$ this means that there is no significant difference in chromium levels from one sampling location to another. This is more elaborated from their mean and standard deviation as thus; Kwangila (15.375±7.575), Unguwa-fulani (21.662±12.562), Sabon-gari (19.728±13.136), Tundun-wada (15.948±8.189) and Industrial area along Jos road (20.642±9.456) respectively. This might be attributed to sampling sites are falling within the same vicinity thereby their source of contamination with chromium are similar which is tannery industries as suggested by [4]. Table 1 also shows $p = 0.951 > 0.050$ this means that there is no significant difference in chromium concentrations from one season to another. Their mean with standard deviation highlights this; harmattan season 2013 (16.780±10.245), dry season 2013 (22.456±12.029), rainy season 2013 (17.824±8.511), harmattan season 2014 (19.572±9.194), dry season 2014 (16.250±10.533) and rainy season 2014 (19.144±13.384) respectively. It showed that the factor which responsible for high level of chromium in wastewater at Kubanni River is available throughout the periods of sampling which is indiscriminate discharge of tannery effluents as this contains high concentrations of chromium as suggested by [1]. Table 2 presents Pearson Product Moment correlation for chromium levels in wastewater between the year 2013 and 2014. Statistical data showed mean with standard deviation level for chromium to be 19.971±8.865 for 2013 while 17.371±11.224 was obtained in 2014 with the degree of freedom (df) = 13, Pearson correlation (r) = 0.724 and $p = 0.002 < 0.050$ that means there is substantial relationship between chromium level in wastewater for 2013 to that of 2014.

ANOVA Table 3 above indicates, $p = 0.002 < 0.050$ shows there is significant difference in chromium concentrations from one sampling location to another. This is elaborated from their mean and standard deviation as thus; Kwangila (4.640±1.567), Unguwa-fulani (5.065±1.954), Sabon-gari (9.023±5.210), Tundun-wada (11.882±4.178) and Industrial area along Jos road (13.285±5.125) respectively. It might be as a result of disparity in distances to tannery/leather industries which far from one sampling site to another as suggested by [22]. Table 3 also shows $p = 0.885 > 0.050$ this means that there is no significant difference in chromium levels from one season to another. Their mean and standard deviation substantiate these; harmattan season 2013 (9.282±7.043), dry season 2013 (10.482±6.468), rainy season 2013 (9.112±4.462), harmattan season 2014 (9.124±5.817), dry season 2014 (8.420±3.731) and rainy season 2014 (6.254±4.041) respectively. This indicates that factor which responsible for high level of chromium in Kubanni River did not affect by change in seasons which is indiscriminate discharged of tannery-effluents as suggested by [19].Pearson Product Moment correlation (PPMC) for chromium concentrations in soil between the year 2013 and 2014 is presented in Table 4. Statistical data showed mean level with standard deviation to be 9.022±5.204 for 2013 while 8.536±5.143 was obtained for 2014 with the degree of freedom (df) = 13, Pearson correlation (r) = 0.671 and p = 0.006 < 0.050 this means that there is moderate relationship between chromium levels in soil for the year 2013 to that of 2014. This decision is jusified since analysis of variance showed similar results (no significant difference from one season to another).

Analysis of Variance in Table 5 shows, p = 0.305 > 0.050 this means that there is no significant difference in chromium levels among varieties of vegetables analyzed. Their mean and standard deviation showed these; carrot (12.292±7.389), lettuce (11.938±5.453), onion (10.765±7.132), spinach (9.190±4.921), cabbage (11.828±5.154), tomato (6.223±2.699) and okro (6.780±4.452) respectively. This might be as a result of anthropogenic activities in the sampling sites as suggested by [12]. Also, Table 5 shows p = 0.984 > 0.050 this means that there is no significant difference in chromium concentrations across the seasons. This implies that chromium levels in the vegetable samplesanalyzed do not change much despite changes in their seasons as reflected from their mean and standard deviation as thus; harmattan season 2013 (10.223±5.084), dry season 2013 (10.173±5.804), rainy season 2013 (10.816±3.993), harmattan season 2014 (10.194±7.561), dry season 2014 (9.146±5.099) and rainy season 2014 (8.604±7.289) respectively. It means that the factor that is responsible for high level of chromium in this studied environment does not change with season, as revealed by the wastewater from the sampling sites. Pearson Product Moment Correlation (PPMC) is presented in Table 6 to elaborate on the relationship between the chromium levels in vegetables for the year 2013 and 2014. Statistical data showed mean with standard deviation level to be 9.218±4.282 for 2013 while 10.501±6.745 was obtained in 2014. Statistical analysis showed Pearson correlation (r) = -0.076, degree of freedom (df) = 19 and p = 0.743 > 0.050 this means that there is negative relationship between chromium levels in vegetable for the year 2013 and 2014 respectively.

CONCLUSION

The levels of chromium analyzed in the various sampling sites were found in this order: Unguwa-fulani > Industrial area along Jos road > Sabon-gari >Tundun-wada > Kwangila while the vegetables showed the order of carrot > lettuce > cabbage > onion > spinach > okro > tomato. In conclusion, it can be deduced that, there is need to find means of removing this heavy metal (chromium) which might make these vegetables unsuitable for human consumption by stop using wastewater to irrigate the farmland in the studied area and stop indiscriminate discharge of refuse into the body of Kubanni River by providing appropriate dumpsites within the vicinity.

REFERENCES

[1] MNV Prasad, Heavy Metal Stress in Plants, 2nd Edition, Springer, United Kingdom, **2004**, 484 – 487.
[2] Agency for Toxic Substance and Disease Registry (ATSDR). Toxicological Profile for Chromium.**1999**, http:www.atsdr.cdc.gov/toxprofiles/tp13.html.
[3] VI Posypaiko; NA Vasina, Analytical Chemistry in Metallurgy, 1st Edition, Mir Publishers, Moscow,**1984**, 47 – 59.
[4] JCW Wong,*J. of Environmental Technology*,**1996,** 17: 407 – 410.
[5] World Health Organization (WHO). Toxicological Evaluation of Certain Food Additives and Contaminants, Cambridge University Press, Cambridge, **1989**, 163-219.
[6] G Zurera; R Moreno; J Salmeron; R Pozo, *J. of Science, Food and Agriculture*,**1989**, 49, 307 – 314.
[7] CMA Ademoroti. Standard Method for Water and Effluents Analysis, 1stEdition,Foludex Press Ltd., Ibadan, **1996**, 22 – 23, 44 – 54 and 111 – 112.
[8] EO Iguisi; II Funtua; OD Obamuwe; *Nigerian Journal of Earth Science*, **2001,** 1: 26 – 36.
[9] EA Olofin. Surface Water Pollution: A Menace to the Quality of Life in Urban Area. Paper Presented at 34th Annual Conference of the Nigerian Geographical Association (NGA), Owerri, **1991**, 45 – 50.
[10] OA Frederick; BA Dada; MJ Garba; I Adanne. Macmillan Nigeria Secondary Atlas, 1st Edition. Macmillan Publishers Limited, Lagos, Nigeria, **2006**, 22 – 27.
[11] EO Iguisi,*Savanna*, **1997**, 18: 17 – 28.
[12] AW Butu, *J. of Natural Sciences and Research*,**2013**, 3, 19 – 25.
[13] APHA. Standard Methods for the Examination of Water and Wastewater, 17th edition, Washington D.C., **1998**, 1269 – 1290.

[14] RD Munson; WL Nelson. Principle and Practices in Plants Analysis in "Soil Testing and Plant Analysis" (ed) Westernan, R.L.; Mandison, SSSA, **1990**, 359 – 387.
[15] Association of Official Analytical Chemist (AOAC). Official Methods of Analysis. 14th Edition, Washington DC, **1995,** 142 – 158.
[16] J Robert. Elementary Statistics, 6th Edition. PWS Publishers, Wadsworth Inc, USA, **1992**, 120 – 129.
[17] JO Nwadiogbu; ET Nwankwere; KA Eze; CC Chime, *Archives of Applied Science Research*,**2013,**5: 159 – 163.
[18] D Chapman. Water Quality Assessment. A Guide to the use of Biota, Sediments and Water in Environmental Monitoring, 2nd Edition, E & F Spon, London, **1997.** File: A//:Hydrology and Water Quality of Lake Merced.htm.
[19] YO Yusuf. A Comparative Analysis of the Suspended and Dissolved Sediment Yield of a Tributary of the Kubanni River, Zaria, Nigeria, Department of Geography, Ahmadu Bello University, Zaria,MSc Thesis (unpublished), **2007**.
[20] Food Agriculture Organization and World Health Organization (FAO/WHO). Joint FAO/WHO Expert Committee on Food Additives **1999**. Summary and Conclusions. Proceedings of the 53rd Meeting, Rome,**1999,** June 1 – 10.
[21] K Yasmeen; M Versiani; R Arain; Q Haque; N Khan; S Ali; A Langha, *J. of Applied Science, Environment and Management,* **2010,** 14: 95 – 99.
[22] JC Akan; FI Abdulrahman; GA Dimari; VO Ogugbuaja, *J. of American Science***2008,** 6: 78 – 87.
[23] K Rehman; S Ashraf; U Rashid; M Ibrahim,*Pakistan J. of Botany*, **2013,** 2: 391 – 400.
[24] N Abdu; AAbdulkadir;JO Agbenin;A Buerkert,*Nutr. Cycl. Agroecosyst*,**2011,** 89: 387 – 397.
[25] OA Sodipo; FI Abdulrahman; JC Akan, *J. Research in Environmental Science and Toxicology*,**2012,** 3: 36 – 40.
[26] DJ Oyedele; C Asonugbo; OO Awotoye,*J. of Environmental, Agricultural and Food Chemistry*,**2006,** 5: 1446 – 1453.
[27] Food Agricultural Organization/World Health Organization (FAO/WHO) Standards. Codex Alimentarius Commission, Rome, **2001.**
[28] NJ Kumar; HI Soni; NK Rita; IJ Bhatt,*J. Agriculture and Environment*, **2009,** 10: 10 – 20.