ChemSearch Journal 7(1): 1 – 10, June, 2016
Publication of Chemical Society of Nigeria, Kano Chapter

Received: 01/03/2016 Accepted: 03/06/2016
http://dx.doi.org/10.4314/csj.v7i1.1

Assessment of Iron 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 iron was determined in wastewater, soil and vegetable (carrot, lettuce, onion, spinach, cabbage, tomato and okro) samples that were collected on seasonal basis from January, 2013 to September 2014 along Kubanni stream channels in Zaria. The results showed iron levels in wastewater were in the range of 3.85 – 42.33mg/L for the year 2013 and 15.60 – 72.08 mg/L in 2014; 0.96 – 12.73mg/Kg for the year 2013 and 4.93 – 18.24 mg/Kg in 2014 for the soil while the vegetables had concentrations in the range of 3.80 – 23.65mg/Kg for the year 2013 and 7.48 – 27.15 mg/Kg in 2014. Statistical analysis revealed no significant difference in iron levels across the locations and seasons for wastewater, soil and vegetables analyzed. Pearson correlation showed moderate ($r = 0.527$) relationship between iron levels in wastewater for the year 2013 and 2014, moderate ($r = 0.526$) relationship was also obtained for the soil between these two years likewise, moderate ($r = 0.597$) relationship was obtained for vegetables cultivated in 2013 and that of 2014 respectively. Iron concentrations obtained in this study was higher than maximum contaminant levels set by Standard Organizations such as W.H.O. and F.A.O for wastewater while the soil and vegetables were within the limits set by these bodies.

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

INTRODUCTION

Iron is the fourth most abundant metal in the earth's crust of which it accounts for about 5% by mass. Iron is most commonly found in nature in the form of its oxides (Knepper, 1981). Iron is used as constructional material, inter alia for drinking–water pipes. Iron oxides are used as pigments in paints and plastics. Other compounds of iron are used as food colours and for the treatment of iron deficiency in humans. Various iron salts are used as coagulants in water treatment (APHA, 1985; NRC, 1989). Iron is present in drinking water, food, soil, air and dust. Iron in the environment arises from both natural and anthropogenic sources. Iron occurs as a natural constituent in plants and animals. Liver, kidney, fish and green vegetables contain 20-150 mg/kg whereas red meats and egg yolks contain 10-20 mg/kg (Philip, 1990). Rice, fruits and vegetables have low iron contents (WHO, 1999). Iron is an essential element in human nutrition, and in the formation of red blood cells. It forms an important constituent of haemoglobin and intercellular enzyme system. Estimates of the minimum daily requirement for iron depends on age, sex, physiological status and iron bioavailability which ranges from about 5 to 10 mg/day (FAO/WHO, 1988). The effects of toxic doses of iron include; depression, rapid and shallow respiration, coma, convulsions, respiratory failure and cardiac arrest. Chronic iron overload results primarily from a genetic disorder (haemochromatosis) characterized by increased iron absorption and from diseases that require frequent transfusions (Bothwell, 1979).

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 (Iguisi *et al.*, 2001). 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 (Olofin, 1991). The most common source of water pollution in developing nations is domestic sewage and refuse. Iguisi *et al.* (2001) is of the opinion that several chemical elements including iron 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 (Ademoroti, 1996).

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 (Fig. 1). 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 (Frederick *et al.,* 2006). 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 (Iguisi, 1997). The entire vegetation and soils of the study area have been under great anthropogenic influences which have greatly modified the entire landscape (Butu, 2013). 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. 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 iron is accumulated in wastewater, soil and vegetables through man-made activities**.**

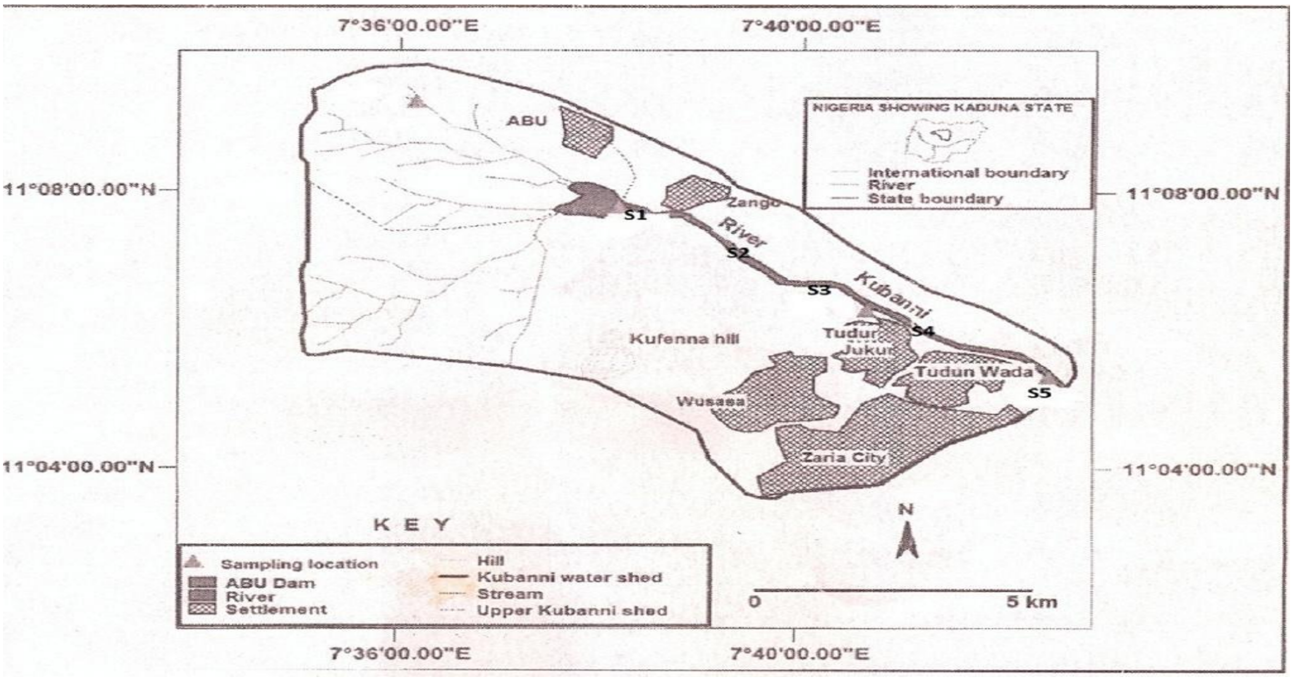

Figure 1: Map of Sampling Locations

MATERIALS AND METHODS

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 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 (Ademoroti, 1996). During sampling, sample bottles used were rinsed with sampled water three times and then filled to the brim at a depth of one meter below 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 (APHA, 1998). 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 *(Brassica oleracea*), 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 iron determinations were acidified at the points of sampling with 5cm^3 of concentrated HNO_3 to avoid microbial activities on the wastewaters which might reduce the concentrations of intended iron before analysis and they were kept in a refrigerator prior to analysis (APHA, 1998). 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, ground to powder and sieved using 250 µm sieve (Samira *et al.,* 2009).

Digestion of Wastewater Samples for Iron Determination

1000 cm^3 of each wastewater sample was transferred into a 1000 cm^3 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 Association of Official Analytical Chemist (AOAC, 1995). Iron was determined at 248nm wavelengths using Atomic Absorption Spectrophotometer (AAS) Alpha-4 Model.

Determination of Iron in Soil Samples

2 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 watch glasses and heated at 90 degrees Celsius on a water bath for 2 hours. 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 Fe at 248nm wavelengths using Atomic Absorption Spectrophotometer (AAS) Alpha-4 Model (AOAC, 1995).

Digestion of Vegetable Samples for Iron Determination

3 grams of the dry sample of each vegetable sample was ashed using muffle furnace set at 450 °C for 3 hours. 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 AOAC (1995).

RESULTS AND DISCUSSION

The results of iron in wastewater, soil and vegetables analyzed were expressed in form of bar-charts. 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 iron analyzed. Statistical decision for Pearson correlation coefficients (r) were in accordance to (Robert, 1992).

Figure 2 shows iron concentrations in wastewater from Kubanni stream channels. Concentrations range of 3.85 – 42.33 mg/L was obtained in the year 2013. Highest level was found at Industrial area along Jos road (42.33 mg/L) followed by 27.40 mg/L at Tundun-wada both in the dry season. High concentrations were also observed at Unguwa-fulani (19.23 mg/L), Sabon-gari (15.38 mg/L) and Industrial-area along Jos road (11.54 mg/L) all these results were obtained in the harmattan season whereas the least level of 3.85 mg/L was noticed at Kwangila sampling site during the rainy season. High concentrations of iron during harmattan and dry seasons could be traced to indiscriminate discharge of industrial-effluents into the body of River Kubanni as reported by Butu (2013). The chart revealed low levels of iron metal during rainy season (3.85 – 7.90 mg/L) and this might be due to dilution effects as suggested by Chapman (1997). In 2014, Kubanni stream channels had iron levels in the range of 15.60 – 72.08 mg/L.

Highest concentration was found at Industrial-area along Jos road (72.08 mg/L) followed by 63.78 mg/L at Tundun-wada and this was closely followed by 58.09 mg/L at Unguwa-fulani sampling site, all these results were obtained in the dry season. High levels of iron recorded in the dry season could be attributed to large amount of wastes generated from alloy-industries and this led to high amount of industrial effluents that was discharged into Kubanni stream channels as suggested by Wong, (1996). High concentrations of iron was also observed during the rainy season with Kwangila sampling site had the highest level of 49.35 mg/L while Sabon-gari and Industrial area along Jos road showed the least levels of 46.68 mg/L respectively. High concentrations of iron in wastewater during rainy season could be as a result of excessive application of fertilizer riches in iron as suggested by Uwah *et al*., (2007). Comparing the results obtained in 2013 with that of 2014, there was remarkable increase in the iron levels from rainy season of 2013 (3.85 – 7.90 mg/L) to rainy season of 2014 (46.96 – 49.35 mg/L). Likewise, increase was observed from dry season of 2013 (12.54 – 42.33 mg/L) to dry season of 2014 (45.20 – 72.08 mg/L). In addition, increase was also noticed from harmattan season of 2013 (7.69 – 19.23 mg/L) to harmattan season of 2014 (15.60 – 38.98 mg/L). This increment in 2014 could be traced to flooding in 2013 that led to heavy erosion and this necessitated the application of chemicals rich in iron more than usual in the following year as suggested by Sodipo *et al.,* (2012). Iron concentration was high at Industrial area along Jos road (3.85 – 72.08 mg/L) throughout the period of sampling as indicated in figure 2. High levels were also found at Unguwa-fulani (7.69 – 58.09 mg/L) and Tundun-wada (5.40 – 63.78 mg/L). WHO/FAO recommends 0.50 mg/L as maximum permissible level for iron in irrigated water and this indicated that wastewaters analyzed were contaminated with iron metals as they exceed the maximum limit. Akan *et al.,* (2008) reported 14.56 – 21.45 mg/L as iron levels in wastewater which was below concentrations obtained in this present study.

Iron concentrations in soil from Kubanni stream channels is presented in figure 3. In the year 2013, the concentrations determined were in the range of 0.96 – 12.73 mg/Kg. Highest level of 12.73 mg/Kg was noticed at Tundun-wada followed by 6.65 mg/Kg at Industrial-area along Jos road and this was closely followed by 6.01 mg/Kg at Sabon-gari sampling site, all these results were obtained in the dry season whereas lowest concentrations were observed at Industrial-area along Jos road (1.92 mg/Kg) and Kwangila (0.96 mg/kg) both in the rainy season. Elevated concentrations of iron during the dry season might be related to prolong use of these sites for farming led to accumulation of heavy metals coupled with nature of wastewaters use for irrigation as suggested by Abdu *et al*., (2011). High concentrations were also obtained at Tundun-wada (9.62 mg/Kg), Industrial-area along Jos road (5.71 mg/Kg) and Unguwa-fulani (5.71 mg/Kg). There was build-up in iron levels from harmattan season (3.85 – 9.62 mg/Kg) to dry season (4.98 – 12.73 mg/Kg). This could be traced to deposition of harmattan-dusts and high application of chemicals like herbicides, fungicides, pesticides as suggested by Nwadiogbu *et al*., (2013) and Abdu *et al*., (2011). Least concentration of iron in soil was noted during rainy season (0.96 – 3.85 mg/Kg) and this might be attributed to dilution effects as suggested by Chapman (1997). The concentrations determined were in the range of 4.93 – 18.24 mg/Kg for the year 2014. Highest level was recorded at Tundun-wada (18.24 mg/Kg) during the dry season followed by 13.54 mg/Kg at Sabon-gari in the harmattan season and closely followed by 13.40 mg/Kg at Sabon-gari but in the dry season. High levels of iron in soil were also found at Kwangila (12.15 mg/Kg) in the rainy season, 12.08 mg/Kg at Tundun-wada sampling sites during the harmattan season and 10.84 mg/Kg at Industrial-area along Jos road. High levels of iron during rainy season could be as a result of excessive application of manure, herbicides, fungicides, insecticides and pesticides coupled with fertilizers as there was heavy rainfall in 2013, and this necessitated high application of more chemicals than usual to nourish the farmland in the following year as suggested by Abdu *et al*., (2011). There were gradual increases in iron levels from harmattan to rainy seasons at Kwangila sampling site (5.48 – 12.15 mg/Kg) and Industrial-area along Jos road (4.98 – 10.84 mg/Kg). Comparing the results obtained in the year 2013 and 2014, there was a remarkable increase in iron level from rainy season of 2013 (0.96 – 3.85 mg/Kg) to rainy season of 2014 (4.93 – 12.15 mg/Kg). Likewise, increment was observed from dry season of 2013 (4.93 – 12.73 mg/Kg) to dry season of 2014 (7.30 – 18.24 mg/Kg). In the same way, increase was noticed from the harmattan season 2013 (3.85 – 9.62 mg/Kg) to the harmattan season of 2014 (4.98 – 13.54 mg/Kg). This increment could be attributed to excessive applications of these chemicals (herbicides, fungicides, insecticides, manure and fertilizers) resulting in the elevated levels of iron as reported by Wong (1996) and Abdu *et al*., (2011). Results obtained in this study was lower than maximum allowable limit set for iron in soil (500 mg/Kg) by FAO/WHO (1985) and this indicated that the soil used for farming in the sampling sites were not polluted with iron metal. Sodipo *et al.,* (2012) reported (178.40±8.60 mg/Kg) as iron levels in soil which was above concentrations obtained in this study.

Figure 4 shows iron levels in vegetables planted along Kubanni stream channels. The concentrations determined were in the range of 3.80 – 23.65 mg/Kg for the year 2013. Highest level of 23.65 mg/Kg was found in okro during the dry season followed by 18.27 mg/kg in tomato at the same season and closely followed by 13.54 mg/Kg for spinach in the harmattan season. High concentrations were also obtained in onion (13.28 mg/Kg), 13.02 mg/Kg in spinach and 12.64 mg/Kg in carrot all these concentrations were obtained in the dry season whereas the least levels were found in tomato (4.21 mg/Kg) and 3.80 mg/Kg in both lettuce and carrot that were planted in the rainy season. Elevated levels of iron during harmattan and dry seasons could be as a result of fertilizer applications combined with extensive use of wastewater to irrigate the farmlands during these periods as suggested by Oyedele *et al.*, (2006) and Abdu *et al.*, (2011). Rainy season (3.80 – 7.69 mg/Kg) showed least levels of iron accumulation and in this period, cabbage (7.69 mg/Kg) had highest level while the lettuce (3.80 mg/Kg) showed the lowest. This might be as a result of dilution effects according to Chapman (1997). Concentrations determined were in the range of 7.48 – 27.15 mg/Kg in the year 2014. Tomato (27.15 mg/Kg) showed highest level followed by okro (22.41 mg/Kg) and this was closely followed by onion (22.40 mg/Kg). All these results were obtained in the dry season and 21.40 mg/Kg was found in onion as determined but in rainy season. High concentrations were also found in spinach (18.21 mg/Kg) during the harmattan season, 17.41 mg/Kg for spinach in the dry season, 15.78 mg/Kg for onion in the harmattan season, 15.70 mg/Kg for cabbage during rainy season while lowest level of 7.48 mg/Kg was noted in tomato during rainy season. The chart showed high concentrations of iron in 2014 which might be as a result of excessive application of chemicals like herbicides, fungicides, pesticides, insecticides coupled with manure and fertilizers applications to nourish the soils that its nutrients had been washed away by flooding in 2013. Comparing the results obtained in 2013 with that of 2014, iron showed high accumulation in vegetable during rainy season of 2014 (7.48 – 21.40 mg/Kg) than rainy season of 2013 (3.80 – 7.69 mg/Kg). Likewise, dry season of 2014 (12.05 – 27.15 mg/Kg) had high levels of iron in vegetable than dry season of 2013 (9.82 – 23.65 mg/Kg). In the same way, there was a remarkable increase in iron levels from harmattan season of 2013 (3.85 – 13.54 mg/Kg) to that of harmattan season 2014 (7.94 – 18.21 mg/Kg). This increment might be due to reason given above as heavy applications of these chemicals increased optimum uptake of iron from soils as observed by Bahemuka and Mubofu (1991). Lettuce (3.81 – 13.01 mg/Kg) showed least accumulation of iron among vegetables analyzed while onion (7.45 – 22.45 mg/Kg) had highest accumulation. Results obtained in this study were lower than maximum permissible limit set by FAO/WHO regulation, 1985 (425.00 mg/Kg). Arora *et al.*, (2008) reported 116 – 378 mg/Kg as iron levels in vegetables cultivated with wastewater which was greater than results obtained in this study.

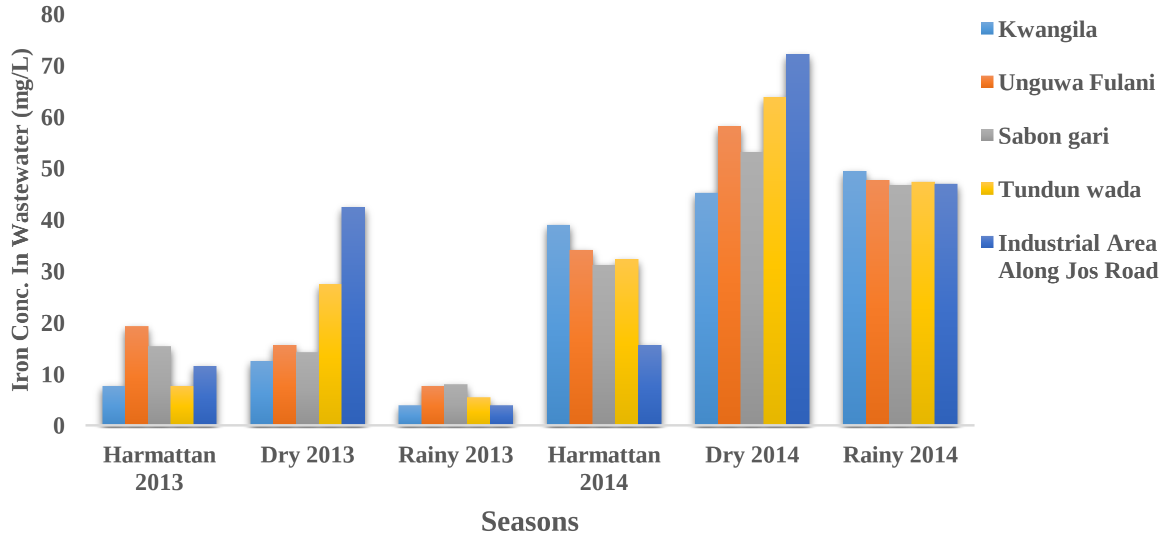

Fig. 2 :- Iron concentrations in Wastewater from Kubanni stream Channels, Zaria

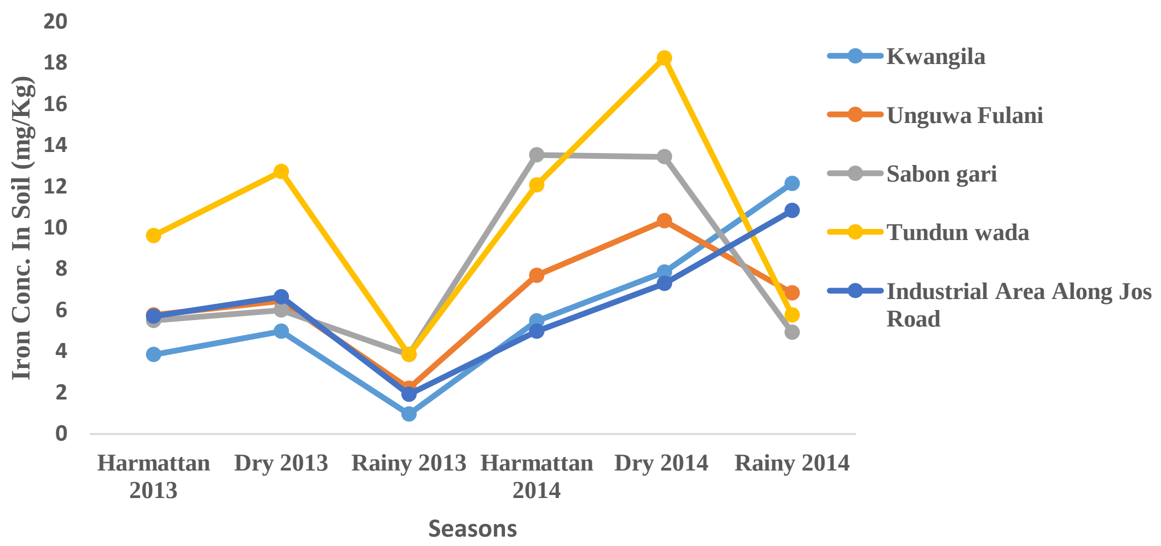

Fig. 3: Iron concentrations in Soil from Kubanni Stream Channels, Zaria

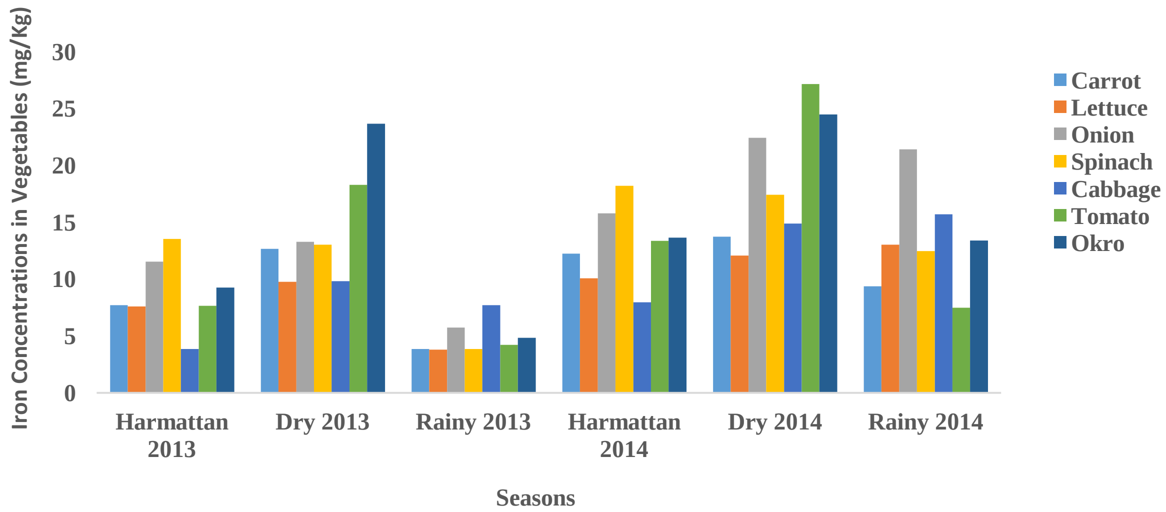

Fig. 4: Iron Concentrations in Vegetables from Kubanni Stream Channels, Zaria

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

Analysis of Variance		Sum of Square	df	Mean Square	F	Signif
Iron in Wastewater (Locations)	Between Groups	126.677	4	31.669	0.067	0.991
	Within Groups	11734.183	25	469.367		
	Total	11860.860	29			
Iron in Wastewater (Seasons)	Between Groups	896.178	5	179.236	0.392	0.849
	Within Groups	10964.682	24	456.862		
	Total	11860.860	29			

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

Variables	*N*	$\bar{x}$	SD	r	df	Signif.
Iron 2013	15	13.489	10.195	0.527	13	0.044
Iron 2014	15	45.480	13.965			

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

Analysis of Variance		Sum of Square	df	Mean Square	F	Signif.
Iron in Soil (Locations)	Between Groups	81.112	4	20.278	1.325	0.288
	Within Groups	382.503	25	15.300		
	Total	463.615	29			
Iron in Soil (Seasons)	Between Groups	42.088	5	8.418	0.479	0.788
	Within Groups	421.527	24	17.564		
	Total	463.615	29			

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

Variables	*N*	$\bar{x}$	SD	r	df	Signif.
Iron 2013	15	5.337	2.978	0.526	13	0.044
Iron 2014	15	9.432	3.907			

Table 5:- Analysis of Variance (ANOVA) for Iron in Vegetable (Varieties and Seasons)

Analysis of Variance		Sum of Square	df	Mean Square	F	Signif.
Iron in Vegetable (Among various vegetable)	Between Groups	179.068	6	29.845	0.832	0.553
	Within Groups	1255.403	35	35.869		
	Total	1434.471	41			
Iron in Vegetable (Seasons)	Between Groups	90.953	5	18.191	0.487	0.783
	Within Groups	1343.518	36	37.320		
	Total	1434.471	41			
Iron Among Wastewater, Soil & Vegetable	Between Groups	8291.930	2	4145.95	29.832	0.000
	Within Groups	13758.946	99	138.979		
	Total	22050.875	101			

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

Variables	*N*	$\bar{x}$	SD	r	df	Signif.
Iron 2013	21	9.310	5.193	0.597	19	0.004
Iron 2014	21	15.055	5.237			

Table 1 shows ANOVA for iron, as it indicates p = 0.991 > 0.050 this means that there is no significant difference in iron concentrations for wastewater from one sampling sites to another. Their mean with standard deviation showed these; Kwangila (26.268±20.440), Unguwa-fulani (30.390±19.667), Sabon-gari (28.072±18.664), Tundun-wada (30.633±22.595) and Industrial-area along Jos road (32.060±26.142) respectively. This shows contamination of Kubanni River with wastewater from nearby household's reminant and industries across the sampling locations are similar. Also, Table 1 shows p = 0.849 > 0.050 this means that there is no significant difference in iron levels across the seasons. This was better illustrated from their mean and standard deviation results; harmattan season 2013 (27.110±10.046), dry season 2013 (20.756±16.773), rainy season 2013 (27.884±18.857), harmattan season 2014 (38.754±18.805), dry season 2014 (29.972±20.641) and rainy season 2014 (32.432±23.469). This might be as a result of the same vicinity of sampling make them exposed to similar anthropogenic activities as suggested by Butu (2013). Table 2 shows Pearson Product Moment Correlation (PPMC) for iron levels in wastewater between the year 2013 and 2014. Statistical data showed mean with standard deviation level for iron to be 13.489±10.195 in 2013 while 45.480±13.965 was recorded in 2014. Statistical analysis showed Pearson correlation (r) = 0.527, degree of freedom (df) = 13 and p = 0.044 < 0.050 this means that there is moderate relationship between iron concentrations in wastewater for the year 2013 and 2014 respectively.

Analysis of Variance in Table 3 above shows, p = 0.288 > 0.050 this means that there was no significant difference in iron concentrations in the soil of the sampling sites. Their mean with standard deviation illustrate these; Kwangila (5.878±3.808), Unguwa-fulani (6.550±2.653), Sabon-gari (7.880±4.408), Tundun-wada (10.382±5.190) and Industrial-area along Jos road (6.233±2.932). This could be as a result of anthropogenic activities and similar soil formation of sampling sites as suggested by Butu (2013) as these locations are relatively close to one another. Also, Table 3 shows that p = 0.788 > 0.050 this means that there is no significant difference in iron levels across the seasons. Their mean with standard deviation results elaborate these; harmattan season 2013 (6.706±3.377), dry season 2013 (6.552±3.241), rainy season 2013 (6.968±3.925), harmattan season 2014 (7.404±2.445), dry season 2014 (6.716±4.509) and rainy season 2014 (9.962±6.462). Table 4 presents Pearson Product Moment correlation (PPMC) for iron levels in soil between the year 2013 and 2014. Statistical data showed mean with standard deviation for iron level to be 5.337±2.978 for 2013 while 9.432±3.907 was obtained in 2014 with the degree of freedom (df) = 13, Pearson correlation (r) = 0.526 and p = 0.044 < 0.050 this mean that there is moderate relationship between iron levels in soil for the year 2013 to that of 2014. The result is jusified since analysis of variance showed similar results (no significant difference from one season to another).

Table 5 presents Analysis of Variance for iron in vegetables and shows p = 0.553 > 0.050 this means that there is no significant difference in iron levels among various vegetables analyzed. Their mean and standard deviation illustrate these; carrot (9.918±3.724), lettuce (9.380±3.323), onion (15.022±6.285), spinach (11.468±6.328), cabbage (11.595±3.555), tomato (13.018±8.538) and okro (14.875±7.815) respectively. Also, Table 5 shows p = 0.783 > 0.050 this means that there is no significant difference in iron concentrations across the seasons. The mean and standard deviation results give these; harmattan season 2013 (13.789±5.911), dry season 2013 (13.550±7.455), rainy season 2013 (10.097±4.242), harmattan season 2014 (12.810±7.924), dry season 2014 (12.576±6.102) and rainy season 2014 (10.273±3.923). This implies iron level is similar within a specify season as their mean are relatively close to one another. In addition, ANOVA Table 5 above indicates p = 0.000 < 0.050 this means that there was significant difference in iron concentrations among wastewater, soil and vegetables of the sampling sites. Their mean and standard deviation were as follow; wastewater (29.485±20.224), soil (7.385±3.998) and vegetables (12.182±5.915) respectively. Table 6 presents Pearson Product Moment Correlation (PPMC) to establish the relationship between iron levels in vegetables for the year 2013 and 2014. Statistical data showed the mean and standard deviation level for iron to be 9.310±5.193 in 2013 while 15.055±5.237 was obtained in 2014. Statistical analysis showed Pearson correlation (r) = 0.597, degree of freedom (df) = 19 and p = 0.004 < 0.050 this means that there is moderate relationship between iron concentrations in vegetables for the year 2013 and 2014 respectively.

CONCLUSION

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

REFERENCE

Abdu, N.; Abdulkadir, A.; Agbenin, J.O. and Buerkert, A. (2011). Vertical Distribution of Heavy Metals in Wastewater-Irrigated Vegetable Garden Soils of three West African Cities. *Nutr. Cycle Agroecosystem* 89: 387 – 397

Ademoroti, C.M.A. (1996). Standard Method for Water and Effluents Analysis. Foludex Press Ltd., Ibadan. Pp. 22 – 23, 44 – 54 and 111 – 112.

Akan, J.C.; Abdulrahman, F.I.; Dimari, G.A. and Ogugbuaja, V.O. (2008). Physicochemical Determination of Pollutants in Wastewater and Vegetable Samples along Jakara Wastewater Channel in Kano Metropolis, Kano State, Nigeria. *European Journal of Scientific Research*, 23: 122 – 133

American Public Health Association (APHA, 1985). Standard Methods for the Examination of Water and Wastewater, 17th Edition, Washington D.C. Pp. 1269 – 1280.

American Public HealthAssociation (APHA, 1998). Standard Methods for the Examination of Water and Wastewater, 18th Edition, Washington, DC Pp. 45 – 60.

Arora, M.B.; Kiran, S.; Rani, A.; Rani, B., Kaur, B. and Mittal, N. (2008). Heavy Metal Accumulation in Vegetables irrigated with Water from Different Sources. *Food Chem.* 111: 811 – 815.

Association of Official Analytical Chemist (AOAC, 1995). Official Methods of Analysis. 12th Edition, Washington DC, Pp. 89 - 95.

Bahemuka, T.E. and Mubofu, E.B. (1991). Heavy Metals in edible green Vegetables Grown along the site of the Sinza and Msimbazi River in Dares Salaam, Tanzania. *Food Chemistry*, 66: 63 – 66.

Bothwell, T. (1979). Iron Metabolism in Man. Oxford, Blackwell, London. Pp 67 – 90.

Butu, A.W. (2013). Concentration of Metal Pollutants in River Kubanni, Zaria, Nigeria. *Journal of Natural Sciences Research* 3: 19 – 25.

Chapman, D. (1997). Water Quality Assessment. A Guide to the use of Biota, Sediments and Water in the Environmental Monitoring, 2nd Edition, E & FN Spon, London, File: A//:/Hydrology and Water Quality of Lake Merced.htm

FAO/WHO (1988). Requirement of Vitamin A, Iron Folate and Vitamin B_{12} Reports of a Joints FAO/WHO Export Consultation. FAO Food and Nutritional Series, No. 23

Food and Agricultural Organization/World Health Organization (FAO/WHO, 1985). Joint FAO/WHO Experts Committee on Food Additives, Summary and Conclusions, 53rd Meeting, Rome: Joint FAO/WHO, 1 – 10 June, 1985.

Frederick, O.A.; Dada, B.A.; Garba, M.J. and Adanne, I. (2006). Macmillan Nigeria Secondary Atlas. 1st Edition. Macmillan Publishers Limited, Lagos, Nigeria. Pp. 22 – 27.

Iguisi, E.O.; Funtua, I.I. and Obamuwe, O.D. (2001). A Preliminary Study of Heavy Metals Concentration in the Surface Water of the Kubanni Reservoir, Zaria. *Nigerian Journal of Earth Science* 1: 26 – 36.

Iguisi, E.O. (1997). An Assessment of the Current Level of Sedimentation of the Kubanni Dam. *Savanna* 18: 17 – 28.

Knepper, W.A. (1981). Iron in Kir-Othmer Encyclopedia of Chemical Technology. Wiley Inter Science, New York. 13:735-753

National Research Council (NRC, 1989). Drinking Water and Academy Press, Washington, D.C., Pp. 23 – 57

Nwadiogbu, J.O.; Nwankwere, E.T.; Eze, K.A. and Chime, C.C. (2013). Trace Metals Airborne Harmattan Dust in Ahmadu Bello University Zaria, Nigeria. *Achieves of Applied Science Research*, 5: 159 – 163.

Olofin, E.A. (1991). 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. Pp. 25 – 30.

Phillips, A.L. (1990). Lead and Other Metals Ions in US Precipitation. *Environmental Sci. Technology* 4: 55 -58

Robert, J. (1992). Elementary Statistics. 6th Edition, PWS Publishers, Wadsworth Inc., USA. Pp. 120 – 140.

Samira, A.M.; Elferjani, H.S.; Haroun, F.A. and Abdelnabi, F.F. (2009). Determination of Available Nitrate, Phosphate and Sulphate in Soil Samples. *International Journal of PharmTech Research*, 3: 598 – 604.

Sodipo, O.A.; Abdulrahman, F.I. and Akan, J.C. (2012). Comparative Elemental Analysis of *Solanum macrocarpum (L.)* and Soil Sample from Alau, Borno State, Nigeria. *Journal of Research in Environmental Science and Toxicology,* 3: 36 – 40.

Uwah, E.I.; Akan, J.C.; Moses, E.A.; Abah, J. and Ogugbuaja, V.O. (2007). Some Anions Levels in Fresh Vegetables in Maiduguri, Borno State, Nigeria. *Agricultural Journal* 2: 392 – 396.

Wong, J.W.C. (1996). Heavy Metal Contents in Vegetables and Market Garden Soil in Hong Kong. *Environ. Technol.,* 17: 407 – 414.

World Health Organization (WHO, 1999). Guidelines for Drinking Water Quality. Health Criteria and Other Supporting Information (2nd Edi. Vol.2). AITBS Publishers, New Delhi. Pp 119-382.