Int. J. Environ. Res., 2(1): 65-70, Winter 2008
ISSN: 1735-6865

Comparative Study of Tomatoes and Onions form Irrigated Farmlnads on the Bank of River Challawa, Kano, Nigeria

Abdullahi, M. S.[1*], Uzairu, A.[1], Harrison, G . F. S.[1], Balaraabe, M. L.[2] and Okunola, O. J.[1]

[1]Department of Chemistry, Ahmadu Bello University, Zaria Nigeria
[2]Department of Biological Sciences, Ahmadu Bello University, Zaria, Nigeria

Received 25 Jan. 2007; Revised 22 July 2007; Accepted 10 Aug. 2007

ABSTRACT: The concentration of Cu, Mn, Ni and Zn were determined in tomatoes and onions samples using Atomic Absorption Spectrometry. A total of 32 samples each of tomatoes and onions were collected from the exposed and control sites for analysis. The trace metals (Cu, Mn, Ni and Zn) concentration in tomatoes wee found to be 6.2406, 6.5521 , 5.7375 and 8.9297 mg/kg^{-1}, respectively. while those of onions samples (exposed and control) are 8.250 for Cu,7.9479 for Mn, 10.8583 for Ni and 98.7292 for Zn; and 5.5698 for Cu, 2.5156 for Mn, 7.8813 for Ni and 6.6573 mg/kg^{-1} for Zn in respect of onions sample (control). The abundance of the trace metals followed the trend of Zn > Mn > Cu > Ni for tomatoes samples (exposed), Zn > Ni > Cu > Mn for onions samples (exposed) and Ni > Zn > Cu > Mn for the onions samples (control). The trace metals levels in the tomatoes and onions were found to be above the FAO/WHO and WHO/EU allowed limits, which put the consumers of these vegetable crops at risk healthwise. However, the Cu and Zn values have not reached the MAFF limit.

Key words: Tomatoes, Onions, trace metals, irrigated farmlands, Challawa River

INTRODUCTION

Food production and its attendant security is an important aspect of a nation's economic stability and as a measure of any growing economy. Food and vegetable crops production requires assess to fertile land, water and in some cases fertilizers, particularly in poor and developing countries of the world. Thus, it requires all the necessary inputs it deserves to realize this goal.

The Nigerian Government in attempts to achieve this goal, have in recent years built additional dams, canals and increased the provision of fertilizers and modern farm equipments to boost both dry and rainy seasons farming of food and vegetable crops due to increased population and rural-urban migration for search of greener pasture.However, the issue of industrial pollution has not been given the much needed attention as required by the laws of the land. Hence, the indiscriminate disposal of untreated industrial effluents by industries. This practice have continued to undermined governments' efforts towards food production to sustain the economy. Mineral elements are known to be essential in our diet and may enter the food crops or vegetables from soil through mineralization by crops, food processing or environmental contamination (Onianwa, *et al*, 2001; Miller, 1996).while efforts are being consolidated by the government towards improving and increasing food and vegetable crops production, the problem of industrial effluents is undermining these laudable efforts especially in Kano where tannery effluents are discharged into the Challawa River which is use for the irrigation of vegetable crops during the dry season farming. Kano, a city in northern Nigeria, "N1159.981", E008, 31.491, is home to 70% of Nigeria's tanneries. Most of the tanneries industries in Kano are concentrated in Challawa Industrial Estate. The effluents generated by the tanneries are channelled into drains and subsequently into the Challawa River. Consequently, the amount of pollutants and wastes generated by the tannery

*Corresponding author: Email-saboms@yahoo.com

industries pose significant stress on the vegetable crops (tomatoes and onions) grown on the bank of Challawa River since the polluted river is used for irrigation to water the vegetable crops along the Challawa River bank farmlands. Thus, in a bid to struggle for survival, the Challawa farmers use the contaminated river water for irrigation purposes. As a result, trace metals may enter the food chain through irrigated tomatoes and onions thereby exposing consumers of these valuable vegetable crops to bioaccumulation of trace metals with time.

There is some information on the levels of trace metals on water, soil and sediments of Challawa River in the literature. However, there are no reports on the levels of trace metals in vegetable crops grown along the Challawa River bank. Thus, there is the need to carry out extensive screening on the food and vegetable crops grown in the vicinity of the Challawa River, especially tomatoes and onions, in order to have more insight into the indiscriminate discharges of the tannery effluents into the Challawa River used for irrigation, fishing, drinking, etc.

Tomatoes and onions are part of human meal and contain trace metals in very minute quantities. Trace metals get into the tomatoes and onions through water used for the irrigation, and soil by mineralization by crops. The levels of these trace metals is increased as a result of natural weathering of rocks, disposal of wastes like car batteries, used metallic household appliances, use of fertilizers, pesticides, herbicides and industrial effluents (Awofolu, *et al,* 2005; Francis, 2005).

These wastes, industrial effluents and run-off from agricultural farmlands where phosphate fertilizers are used during both dry and rainy seasons, are washed into rivers particularly the Challawa River which in turn are passed into the tomatoes and onions and perhaps other vegetable crops that are irrigated using the Challawa River water.

The threat to human lives posed by the tannery industries cannot be dismissed ordinarily. This is because the presence of toxic metals in the environment has continued to generate a lot of concern to environmental scientists, government agencies and health practitioners (Awofolu, 2005). This according to him, was due to the health implications of their presence in our food and vegetable crops since they are non-essential metals that are not required for any function either by plants or animals, hence they are usually monitored for health purposes. Trace metals been referred to as common pollutants, which are widely distributed in the environment with sources from weathering of mineral, soil, fertilizers run-off from agricultural activities, industrial effluents, etc (Merian, 1990; O'Neil, 1993). However, levels of these metals in the environment have increased tremendously in the past decades as a result of human inputs and activities. Some studies according to Awofolu (2005) have reported the transfer of trace metals from the contamination of soil to plants and from plants to livestock with subsequent transfer to man through the food chain. According to Nnorom, *et al.*, (2007), environmental pollution is the main cause of trace metal contamination in the food chain.

Manganese has it source from industrial effluents and at certain level, it is toxic to a number of crops. However, there is no available data of human toxicity (Cornish, *et al,*1999). Zinc has its sources ranging from plumbing works, animal wastes, pesticides, metal works, industrial effluents, etc. Zinc is toxic to many plants at widely varying concentrations. However, it has been found to have low toxicity to man. Prolonged consumption of large doses can result in some health complications such as fatigue, dizziness and neutrophenia (Awofolu, *et al,* 2005). Although, Zn is an essential element involved in metabolic functions and is important for both man and plant health growth (Jeffery, 1992). But plants do not accumulate Zn to a degree that would be toxic to animals or humans. The Zn content of normal plant tissues varies according to species, but it is usually within the range 5-300 mg/kg (Wallsh, 1971). Cornish, *et al,* (1999) noted that no major hazard to man has been documented. Nickel is a naturally occurring element found in a number of mineral ores including nickel sulphides, oxides and silicates. It is present in the enzyme urease and as such is considered to be essential to plants and some domestic animals (Awofolu, *et al,* 2005). However, the essentiality of Ni to man has not been demonstrated, but Ni – related health effects such as renal, cardiovascular, reproductive and immunological effects have been reported in animals. Also, its toxic effects in man are related to dermal, lung and nasal sinus cancer (Holynska, *et al*, 1996).

Copper is among the trace metals that are essential to life but could be toxic at elevated levels. It is toxic at low concentration in water and is known to cause brain damage in mammals (Awofolu, 2005). Elevated levels of copper has however been found to be toxic (Spear, 1981). Copper content of normal plant tissues varies according to species but is usually within the range 1 – 25 mg/kg (Walsh, 1971). It is toxic to man at concentration of 250mg/day (Bowen, 1979). Toxicity of copper in plants as a result of high level in sewage treated agricultural soil has been reported (Awofolu, 2005). Contribution to copper environmental burden could be by atmospheric deposition from metal industries and power plants that are burning fossil fuels. The interest in determination of copper lies between the threshold of essentiality and toxicity (Awofolu, 2005).

MATERIALS & METHODS

Analytical reagent (AnalaR) grade chemicals and distilled water were used throughout the study. All glasswares and plastic containers used were washed with detergent solution followed by soaking in 10% (v/v) nitric acid and then rinsed with distilled water (Awofolu, 2005).

The tomatoes and onions irrigated from the Challawa River bank were freshly harvested from three farms sites and packaged into labeled paper bags. The samples were moved straight to the laboratory for first hand treatment with distilled water. Samples were collected from both the study and control sites, except for tomatoes which were not available at the control sites at the time of sampling.

The tomatoes and onions samples were cut into nearly uniform size. This was done to facilitate drying of the pieces at the same rate. The cut pieces were placed in clean acid-washed porcelain crucibles according to label and oven-dried at 105 °C for 24 h. in Mommert oven (Schutzart DIN 400-50-IP20) until they were brittle and crisp. At this stage no micro-organisms can grow and care was taken to avoid any source of contamination. All crucibles were labeled according to sample numbers. The dried tomatoes and onion samples were pounded into fine particles using acid-washed mortar and pestle. The powdered samples were placed in labeled Petri dishes and dried to constant weight in desiccators with charged Silica gel until they were digested (Awofolu, 2005).

In order to ascertain the reliability of the method for the analysis of the samples for Cd, Cr and Pb, Certified Standard Reference Materials (CSRM) were not readily available for use, instead spiking method was adopted using digestion method (Awofolu, 2005).

Samples were digested according to Awofolu (2005). About 30 mL of the multi-element standard solution was drawn with graduated pipette and used to spike 0.5 g of the sample in a 100 mL beaker. About 5 mL of concentrated perchloric nitric acid were added, and few boiling chips were added. The mixture was heated at 70 °C for 15 min. until a light coloured solution was obtained (digestion complete). The sample solution was not allowed to dry during digestion. The sample solution was filtered into a 50 mL standard flask and two 5 mL portions of distilled water were used to rinse the beaker and the contents filtered into the 50 mL flask. The filtrate was allowed to cool to room temperature before dilution was made to the mark and the content mixed thoroughly by shaking. The digestion was carried out in triplicate for both samples and blank. The digest was run on Atomic Absorption Spectrometry and absorbances of the trace metal in spiked and unspiked tomatoes and onions samples obtained. Thus, concentrations of the trace metals in both samples were used to calculate the percentage recovery in order to validate the method adopted. Each of the tomatoes, onions and blank samples were digested as above and run on the Atomic Absorption Spectrometry. The amount of each of the samples was determined from the calibration plot. This gave the amount of the trace metals in unspiked samples and provided the basic for the spiking experiment. Samples were digested as described by Awofolu (2005). Thus, 0.5 g of the pre-digested tomatoes and onions samples were weighed into a 50 mL beaker, 5 mL of concentrated nitric acid and 2 mLof perchloric acid were added and the mixture digested as above. The digests were run on Atomic Absorption Spectrometry.

Appropriate working standards were prepared for each of the metal solution by serial dilution of the stock solutions. Each of the sets of serial dilutions was then aspirated one after the other into the Atomic Absorption Spectrometry and their absorbance recorded. Calibration curves were plotted for each of the trace metals standard using absorbance against concentrations.

RESULTS & DISCUSSION

The results of recovery of tomatoes and onions samples are shown in Table 1 below. The mean percentage recoveries for the metals Mn, Ni, Cu and Zn are 95.80%, 91.60%, 97.20% and 90.00% for the tomatoes samples, while onions samples have 91.60%, 95.00%, 86.10% and 96.60% respectively. These recoveries validate the experimental procedure adopted.

Table 1. Percentage (%) Recoveries of Tomatoes and Onions Samples

Trace metal	% mean Recovery (tomatoes)	% Mean recovery (Onions)
Mn	95.80	91.60
Ni	91.60	95.00
Cu	97.20	86.10
Zn	90.00	96.60

The results of tomatoes and onions samples showing the mean (± SD) and concentration range are in Table 2. However, the mean concentration range of the trace metals Mn, Ni, Cu and Zn for the tomatoes samples (exposed) are Mn (2.67–8.75 mg/kg), Ni (2.00 – 9.90 mg/kg), Cu (2.25 - 10.00 mg/kg) and Zn (6.83 – 11.67 mg/kg), while the mean concentration range for the onion samples (exposed) are Mn (2.50-4.50 mg/kg), Ni (7.90 – 13.90 mg/kg), Cu (7.00 -9.50 mg/kg) and Zn (6.00 – 11.00 mg/kg); and onions samples (control) have Mn (0.75 – 4.50 mg/kg), Ni (5.90 - 9.90 mg/kg), Cu (4.00 – 7.00 mg/kg) and Zn (4.00 -8.50 mg/kg).

The trend of occurrence of trace metals concentration in the tomatoes sample (exposed) follows the order: Zn > Mn > Cu > Ni. This trend shows that tomatoes samples (exposed) have high levels of Zn and Mn than Cu and Ni. This is similar to the earlier observation on the levels of trace metals in tomatoes by Audu and Lawal (2005) for both dry and rainy seasons determination. However, the trend of occurrence of the trace metals in the onions samples (exposed and control) follows the order: Z > Ni > Cu > Mn and Ni > Zn > Cu > Mn, respectively. Thus, the concentration of Zn and Ni are higher than those of Cu and Mn in the onions samples (exposed) and same in the onions samples (control) but with a slight change between Ni and Zn. Otherwise the trend is same in terms of Cu and Mn. The same observations was reported by Awofolu, *et al* (2005) as Ni > Zn > Cu for the metals analysed. But the trend is quite different with an earlier observation by Audu and Lawal (2005), where the trend follows the order: Zn > Cu > Mn > Ni in onions samples of the dry season. In this study, however, Zn shows higher concentration in both tomatoes and onions samples (exposed), while Ni was highest in onions samples (control). Thus, in all the samples, the trace metals concentrations are higher than the FAO/WHO and WHO/EU allowed limit, but the concentrations of Cu and Zn are by far below the MAFF allowed limit of 50 mg/kg and 20 mg/kg, respectively. Summarily, the trace metals concentrations fall within the normal range but have not reached the phytotoxic level (Table 3).

Table 2. Mean (± SD;mg/kg) and concentration Range of Trace Metals Tomatoes and Onions samples

Site	Tomatoes				Onions			
Study Area	Mn	Ni	Cu	Zn	Mn	Ni	Cu	Zn
Mean (± SD)	6.55 ±1.48	5.74±1.76	6.24±2.22	8.93±1.15	7.95 ± 0.66	10.86 ± 1.79	8.25 ± 0.58	8.33 ± 1.48
Range	2.67 – 8.75	2.00 – 9.90	2.25 – 10.00	6.83 – 11.67	2.50 – 4.50	7.90 – 13.90	7.00 – 9.50	6.00 – 11.00
Control Area								
Mean (± SD)	-	-	-	-	2.52 ± 0.87	7.88 ± 1.36	5.57 ± 0.98	6.66 ± 0.82
Range	-	-	-	-	0.75 – 4.50	5.90 – 9.90	4.00 – 7.00	4.00 – 8.50
FAO/WHO limit	-	-	5.0	0.3	-	-	5.0	0.3
MAFF limit	-	-	50	20	-	-	50	20
WHO/EU limit	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

The concentrations range of the trace metals obtained in this study fall within the levels reported by Onianwa, *et al.*(2001), Erwin and Ivon (1992), Elson and Haas (2002), Pushpanjali and Santosh (1995), Pennington, *et al.* (1995), John and Stephen (1982) and Audu and Lawal (2005). This comparison is shown in Table 4 below.

Table 3. Shows the Normal and Phytotoxic Levels (mg/kg) for metals found in plant leaves

Trace Metal	Normal Range	Toxicity Range
Cd	0.1 – 2.4	5 – 30
Pb	5 – 10	30 – 300
Zn	1 – 400	100 – 400
Cu	5 -20	20- 100
Ni	0.02 – 5	10 – 100

Source: Awofolu. *et al.*, (2005)

Table 4. Trace metals concentration Ranges (mg/kg) in tomatoes and onions samples from Challawa River Bank and published ranges in tomatoes and onions in some countries

Trace Metal	This study Conc. Range		Published Conc. Range in some countries	
	Tomatoes	Onions	Tomatoes	Onions
Cu	2.50 - 10.00	7.00 -9.50	0.63 – 1.11[g], 0.36[a], 0.70[e]	4.20- 7.50[g], 7.30[a]
Mn	2.667 – 8.750	2.50- 4.50	2.95-5.39[g],1.02[e]	1.45 – 1.98[g], 3.32[f], 18[a].
Ni	2.00 – 9.900	7.90 – 13.90	0.75 – 1.20[g], 1.20[c]	0.41 -0.99[g]
Zn	8.833 – 11.667	6.00 – 11.00	1.30 – 2.54[g], 1.00[a], 2.20[e]	10.33-18.89[g], 17.30[a] 25.90[d], 3.53[a], 22.10[d]

Key:
a = Onianwa, *et al.* (2001)
b = Erwin and Ivon (1992)
c = Elson and Haas (2001)
d = Pushpanjanjali and Santosh (1995)
e = Pennington, *et al.* (1995)
f = John an Stephen (1982)
g = Audu and Lawal (2005)

CONCLUSION

The results indicate that both tomatoes and onions (exposed) have relatively high levels of the trace metals than control values in onions. Though, the trace metal levels were higher than the Food and Agricultural Organization (FAO) and the WHO/EU joint limits but have not reached the toxicity level. The high levels of these trace metals in tomatoes and onions could put the consumers of these and other vegetable crops grown within the Challawa River bank at health risk with time, except an urgent step is taken by the government to address this issue. However, concentrations of metals in these vegetable crops will provide baseline data and there is a need for intensive sampling of the same for quantification of the results. Soil, plant and water quality monitoring, together with prevention of metals entering the plant is a prerequisite in order to prevent potential health hazards of irrigation with sewage fed water.

REFERENCES

Audu, A. A. and Lawal, A. O., (2005). Variation in Metal Contents of Plants in Vegetable Gardens Sites in Kano Metropolis. J. Appl. Sci. Environ. Manag., **10** (2). 105 – 109.

Awofolu, O. R., (2005). A Survey of Trace Metals in Vegetation, Soil and Lower Animal along some selected Major Roads in Metropolitan City Lagos. Environ. Monitor.Assess., **105**, 431 – 447.

Cornish, G. A., et al., (1999): Water Quality and Peri-Urban Irrigation. An Assessment of Surface Water Quality for Irrigation and its Implication for Human Health in the Peri-Urban Zone of Kumasi, Ghana. Report OD/TN 95. H.R. Wallingford.

Elson, M. Haas, M. D., (2001): Excerpted from Staying Healthy with Nutrition. The Complete Guide to Diet and Nutritional Medicine. Available from http:// www.healthy. net/ templates/article.GSP

Erwin, J. M and Ivo, N., (1992). Determination of Lead in PLANT Tissues: A Pitfall due to Wet Digestion Procedures in the Presence of Sulphuric Acid. Analyst, **17**, 23 – 26.

FAO/WHO, (1993). Food Additives and Contaminations. Joints FAO/WHO Food Standards Programme. 2001 ALINORM 01/12A.1 – 289.

Francis, O. A., (2005). Trace Heavy Metals Contamination of Soils and Vegetation in the Vicinity of Livestock in Nigeria. EJEAF Chem., **4** (2), 866 – 867.

Holynska, B., et al., (1996). Simple Method of Determination of Copper, Mercury and Lead in Potable Water with Preliminary Pre-Concentration by Total Reflection X- Ray Fluorescence Spectrometry Spectrohin. ACTA Part B. At Spectrosc., **51** (7): 769 – 773.

Jeffery, P. K., (1992). Environmental Toxicology. London Edward ARNOLD Limited, 68 – 78.

John, W. J., Stephen, G. C., (1982). Critical Evaluation of Multi-Element Scheme Using Plasma Emission Anhydride Evolution Atomic – Absorption Spectrometry for the analysis of plant and animal tissues. Analyst., (1273), 353 -369.

Merian, E., (1991). Metals and their Compounds in the Environment. Occurrence, Analysis and Biological Relevance. UCH. Weinheim New York, 45.

Miller-Ihli, N. J., (1996). Atomic Absorption and Atomic Emission Spectrometry for the Determination of Trace Elements Contents of selected Fruits consumed in the United States. J. Food Compos. Anal., **9**, 301 – 311.

Nnorom, I. C., Osibanjo, O. and Ogugua, K., (2007). Trace Heavy Metals Levels of some Bouillon Cubes and Food Condiments Readily consumed in Nigeria. Pakistan J. Nutrit., **6** (2), 122 – 127.

O' Neil, P., (1993). Environmental Chemistry. Chapman and Hall, London. 193.

Onianwa, P. C., Adaeyemo, A. O., Idowu, E. O. and Ogabiela, E. E., (2001). Copper and Zinc Contents of Nigeria Food and Estimate of the Adult-Dietary Intakes. Food Chem., **72** , 89 -95.

Pennington, J. A. T., Schoen, S. A., Salmon, G. D., Young, B., Johanson, R. D. and Marts, R. W., (1995). Composition of Company Foods of the USAFood Supply. 1982 -1991. J. Food Compos. Anal., **8** (2): 129-169.

Pushpanjali, J. and Santosh, R., (1995). The Composition of Indian Foods –Mineral Composition and Intakes of Indian Vegetarian Populations. J. Sci. Food Agric., **67**, 267 – 276.

Walsh, L. M., (1971). Instrumental Methods of Analysis of Soils and Plant Tissues, Soil Science Society of America, inc Madison Wisconsin, USA, 26 –30.

Yisa, J., Morgan, W. and Ayan, P., (2004). Tannery Effluents Analysis for Challawa Industrial Estate. Nigeria. A Paper Presented at the 16th Annual Conference of International association of Nigerian Studies and Development held at Pioneer Hotel, Wuse, Zone 4, Abuja, Nigeria.