INTERNATIONAL JOUNAL OF:
SOCIAL HEALTH AND MEDICAL RESEARCH

TIMBOU-AFRICA ACADEMIC PUBLICATIONS
INTERNATIONAL JOURNAL, FEBRUARY, 2022 EDITIONS
VOL. 8 NO. 3 ISSN: 2373-1340

ANALYSIS OF HEAVY METALS FOUND IN VEGETABLES FROM THOMAS DAM IN KANO STATE, NIGERIA

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ABSTRACT

The use of Water for irrigation on vegetable gardens is a public health concern. Using atomic absorption spectrophotometry (AAS), concentrations of Pb, Ni, Cr, Mn, Fe Co, Cu, Pb and Zn were determined in two different vegetables, including, Okra and Spinach, grown in the

Introduction

Vegetables are rich sources of vitamins, minerals, and fibers, and also have beneficial anti-oxidative effects. However, intake of heavy metal-contaminated vegetables may pose a risk to the human health. This is because, heavy metals have the ability to accumulate in living organisms and at elevated levels they can be toxic. It has been reported that prolonged consumption of unsafe concentrations of heavy metals through foodstuffs may lead to the chronic accumulation of the metals in the kidney and liver of humans causing disruption of numerous biochemical processes, leading to cardiovascular, nervous, kidney and bone diseases (Jarup, 2003).

Determination of the chemical composition of plants is one of the most frequently used methods

vicinity area of Thomas dam in Kano state, Nigeria. Samples were collected during Rainy, dry and cold seasons. The mean level of metals obtained ranged widely from 0.19 -0.34mg/Kg Cr, 0.2-0.54 mg/Kg Co, 0.43-0.75 mg/Kg Cu, B.D.L Ni, 0-1.47 mg/Kg Pb, 2.86-8.37 mg/Kg Zn, 0.41-0.53 mg/Kg Cd, 1.76- 7.2mg/Kg, Mn and 1.6-6.6 mg/Kg Fe for both rainy, dry and cold season for spinach. The mean level of metals obtained in okra ranged widely from 0.30 -0.60mg/Kg Cr, 0.65-0.8 mg/Kg Co, 4.1-6.11 mg/Kg Cu, B.D.L Ni, 0-1.47 mg/Kg Pb, B.D.L, 2.98-4.23mg/Kg Zn, 2.15-3.75mg/Kg Cd, 2.3-5.4mg/Kg, Mn and 2.23-2.67mg/Kg Fe for both rainy, dry and cold season for okra. Comparison of results with the control showed significant levels ($p<0.05$) of all the metals analyzed in the vegetable samples obtained from the vicinity area irrigated dam. However, the levels were within the National Agency for Food and Drug Administration and Control (NAFDAC) tolerable limits for metals in fresh vegetables.

Keywords: *Irrigation, vegetables, metals, atomic absorption spectrophotometry (AAS), Dam*

of monitoring environmental pollution. Various plants have been used as bioindicators (Kasanen and Venetvaara, 1991). Several studies have been reported on the accumulation of environmental pollutants in plants. In Israel, for example lichen and higher plant species were exposed near industrial areas in order to detect the accumulation of heavy metals in these plants (Naveh *et al.*, 1979). Tree barks and their leaves remain in the environment for a long period and are sensitive indicators of the environmental contamination with heavy metals, sulphur and fluorine (Ayodele and Ahmed, 2001).

The impacts of dams on peoples live hood, health, social systems and culture are not easily quantified and often not considered in the analysis of the benefits to the dams (Adefemi and Awokunmi, 2010). In Nigeria, there has been an upsurge in dam's construction in the past decades (Bamishaiye *et al., 2011*). A total of 323 dams have been identified in literature out which 246 (76.2%) were constructed between, 1970 and 1995. While many benefits have been derived from the services of dams, their construction and operation have led to many significant negative social health and human impact (Jimoh *et al., 2011*). Dams can adversely impact the quality of the surface waters and habitat in the streams or river where they are located. A variety of impact can result from the citing, construction and operation of these facilities (EHS online, 2009).

Heavy metals present obvious concern due to their persistence in the environment since they cannot be degraded or destroyed (Galadima Garba, 2012). Occurrence of heavy metals in water indicate the presence of natural or anthropogenic sources. The main natural sources of metals in water are chemical weathering of minerals and soil leaching. The anthropogenic sources are associated mainly with industrial and domestic effluents, urban storm, and water run-off, landfill, mining of coal and ore, atmospheric source and imputes from agricultural activities (El-Buraie, 2010).

Reservoirs in Kano state have subjected to contaminating materials capable of initiating the impairment of the aquatic environment. Untreated industrial effluents are discharged into water bodies (Bichi, 2013) because most industries in Kano do not have waste water treatment facilities. This poses a great threat to the aquatic environment (El-Buraire, 2010). Heavy metals are dangerous because they are accumulative, non-biodegradable and have a long biological half-life. The study of toxic heavy metals in reservoir is very important due to their non-biodegradable nature, accumulative properties and long biological half-lives. It is difficult to remove them completely from the environment once they enter into it. With increase sources of metals pollution in the Kano environment, from small and medium scale dyeing industries, coupled with indiscriminate dumping of industrial wastes into the drainage system, there is need for public awareness on the dangers associated with metals pollution of the environment.

The objectives of this study were to analyze the vegetable samples from the irrigation sites for heavy metals and to compare results obtained with one another and with those of National Agency for Food and Drugs Administration and Control (NAFDAC) safe limits, while using vegetable (spinach, and okra) samples from Thomas Dam . The metals of interest include cobalt (Co), chromium (Cr), copper (Cu), nickel (Ni), lead (Pb) and zinc (Zn), Manganese (Mn), Iron (Fe) and Cadmium (Cd). The results obtained from this study will be useful for assessing the metals contamination and as well as determining the need for remediation. The results would also provide information for background levels of metals in the vegetables in the study area.

Study Area

Thomas Dam is located within Sudan savannah zone of Nigeria ($12^o16'44''$ N - $21^o18'35''$N and $8^o30'5''$E – $8^o31'34''$E) with two distinct wet and dry seasons. The rainy season lasts from May to October and dry season runs from November to April (Shitu, 2006). The Dam is about 585 square meters, while its depth is about 30 m. The dam is sited near Danmarke village of Dambatta Local Government area of Kano State, 30 km away from the ancient Kano City (Kutama *et al.*, 2013).

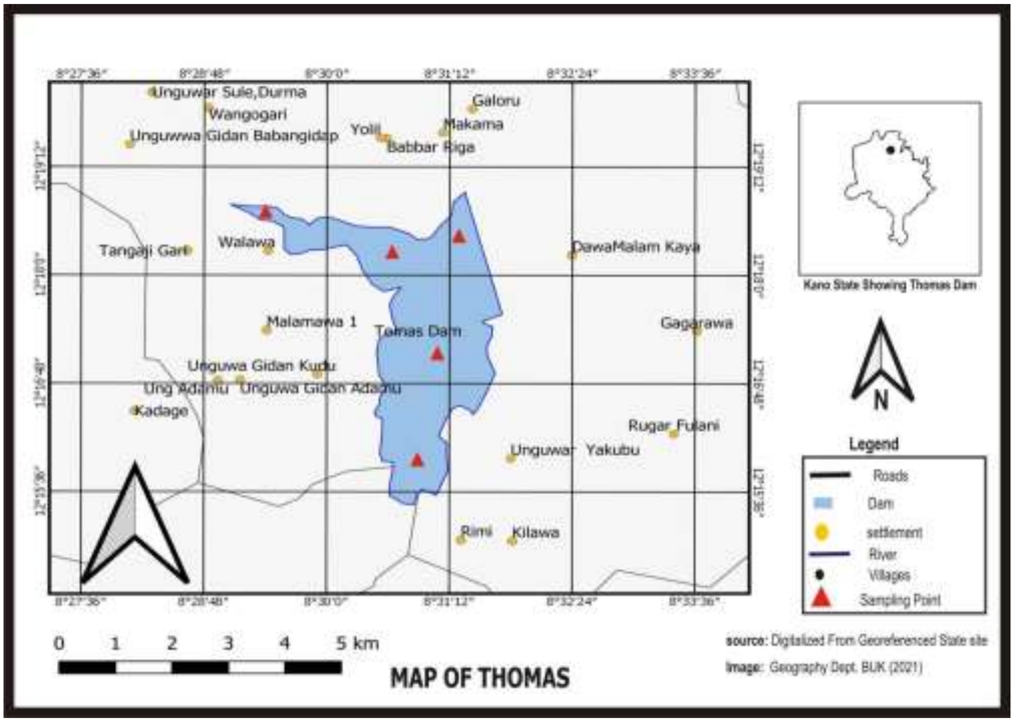

Figure 1: Map of Thomas Dam

MATERIALS AND METHODS

Analytical reagent (AnalaR) grade chemicals and distilled water were used throughout the study. All glassware and plastic containers used in this work were washed with detergent solution followed by 20%(v/v) nitric acid and then rinsed with tap water and finally with distilled water.

Sampling and sample treatment

The vegetables analyzed include spinach and okra. Samples were collected in three season of the year from different location. The first round of sampling was carried out in May towards the end of the dry season while the second round was in September at the peak of the rainy season and the third were collected in November during cold season. Each sample was randomly handpicked, wrapped in a big brown envelope and labelled.

In the laboratory, each sample was washed with tap water and thereafter with distilled water and then dried in an oven at 80°C (Larry and Morgan, 1986). At the end of the drying, the oven was turned off and left overnight to enable the sample cool to room temperature. Each sample was grounded into a fine powder, sieved and finally stored in a 250 cm^3 screw capped plastic jar appropriately labelled.

Digestion procedure

A 2.0 g of the sample was weighed out into a Kjaedahl flask mixed with 20 cm^3 of concentrated sulphuric acid, concentrated perchloric acid and concentrated nitric acid in the ratio 1: 4: 40 by volume respectively and left to stand overnight. Thereafter, the flask was heated at 70°C for about 40 min and then, the heat was increased to 120°C. The mixture turned black after a while (Erwin and lvo, 1992). The digestion was complete when the solution became clear and white fumes appeared. The digest was diluted with 20 cm^3 of distilled water and boiled for 15 min. This was then allowed to cool, transferred into 100 cm^3 volumetric flasks and diluted to the mark with distilled water. The sample solution was then filtered through a filter paper into a screw capped polyethylene bottle.

Result and discussion

The mean concentrations of Co, Mn, Cd, Fe, Cr, Cu, Ni, Pb and Zn in different vegetable samples from the irrigated sites are presented in Tables below

Table I: Concentration of heavy metal in plant (Spinach) for all the sampling location in both Rainy Dry and cold season

	Co	Cr	Cu	Ni	Pb	Zn	Cd	Mn	Fe
		Rainy Season							
THOMAS	0.8	0.6	6.11	B.D.L.	B.D.L.	4.23	3.75	5.4	2.56
		Dry Season							
THOMAS	0.72	0.4	4.97	B.D.L.	B.D.L.	3.29	2.43	2.5	2.67
		Cold Season							
THOMAS	0.65	0.3	4.1	BDL	BDL	2.98	2.15	2.3	2.23

Table II: Concentration of heavy metal in plant (okra) for all the sampling location in both Rainy Dry and cold season

	Co	Cr	Cu	Ni	Pb	Zn	Cd	Mn	Fe
		RAINY SEASON							
THOMAS	0.54	0.34	0.54	B.D.L.	B.D.L.	2.86	0.53	1.76	1.2
		DRY SEASON							
THOMAS	0.24	0.19	0.75	BDL	1.47	8.37	0.42	7.2	6.6
		COLD SEASON							
THOMAS	0.2	0.2	0.43	BDL	BDL	4.5	0.41	5.89	5.2

The mean concentrations of Co, Cr, Cu, Ni, Pb and Zn in different vegetable samples from the three effluent irrigated sites and the control are listed in Tables 1A and B.

The results generally show significant levels ($p < 0.05$) of metals in vegetable samples obtained from the irrigated site. The high concentrations of heavy metals observed in the vegetable samples from the irrigated gardens might be related to the concentrations of the metals in the soil (Al Jassir et al., 2005; Akinola and Ekiyoyo, 2006). Also from the results, general reductions in metal levels were observed in vegetables sampled during the rainy season when compared with those sampled during dry season.

This may be due to the fact that during the rainy season, the gardens were not irrigated with the wastewater. There is also the possibility of rainwater leaching away parts of the metals that have accumulated in the soil, thus reducing the quantity of these metals available to plants in the soil.

Generally, the mean level of metals obtained ranged widely from 0.19 -0.34mg/Kg Cr, 0.2-0.54 mg/Kg Co, 0.43-0.75 mg/Kg Cu, B.D.L Ni, 0-1.47 mg/Kg Pb, 2.86-8.37 mg/Kg Zn, 0.41-0.53 mg/Kg Cd, 1.76- 7.2mg/Kg, Mn and 1.6-6.6 mg/Kg Fe for both rainy, dry for spinach figure II. The maximum value recorded is below the National Agency for Food and Drug Administration and Control's (NAFDAC) maximum tolerable Cu concentration of 40 mg/Kg in fresh vegetables. Ni was below detectable level in the sampling site. The dietary limit of metals in food, vegetable and soil is very important and permissible limits of the metals in agricultural soils, waters and vegetables have been reported by FAO/WHO (WHO, 2008). from the result obtained Zn has higher value, but when compared with the FAO/WHO permissible limit it's within the value recommended.

The mean level of metals obtained in okra ranged widely from 0.30 - 0.60mg/Kg Cr, 0.65-0.8 mg/Kg Co, 4.1-6.11 mg/Kg Cu, B.D.L Ni, 0-1.47 mg/Kg Pb, B.D.L, 2.98-4.23mg/Kg Zn, 2.15-3.75mg/Kg Cd, 2.3-5.4mg/Kg, Mn and 2.23-2.67mg/Kg Fe for both rainy, dry for okra figure III. When compared with the FAO/WHO the concentration of copper obtained are below the WHO/FAO permissible limit of 30mgkg^{-1}. Copper was extensively translocated, as it is essential to the plant metalloenzymes diamine oxidase, ascorbate oxidase, cytochrome C oxidase, superoxide dismutase and plastocyanin oxidase.

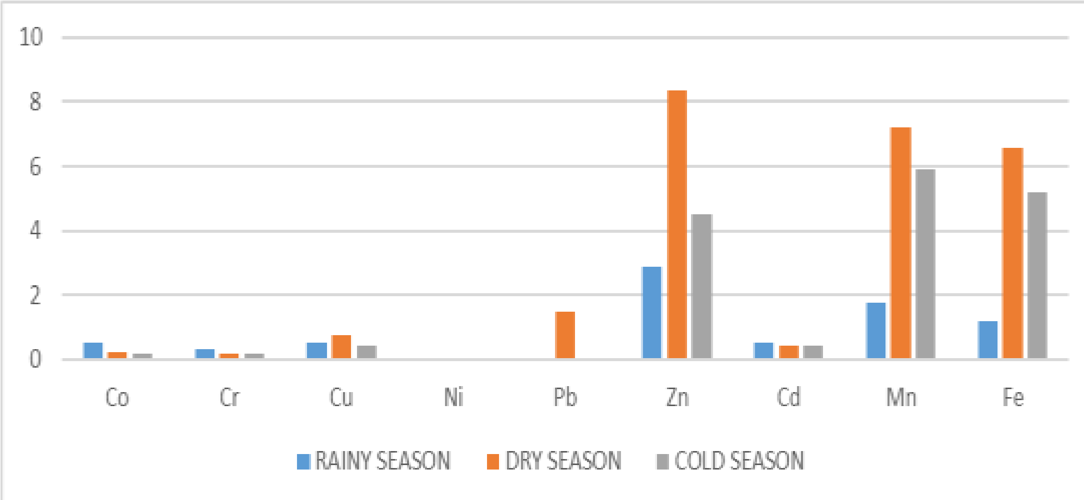

Fig. II: Concentration of heavy metal in plant (Spinach) for all the sampling location in both Rainy Dry and cold season

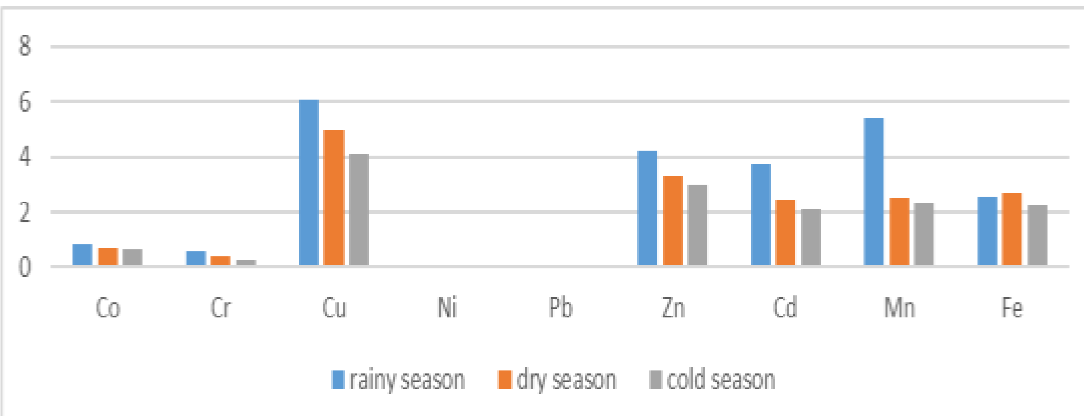

Fig. III: Concentration of heavy metal in plant (okra) for all the sampling location in both Rainy Dry and cold season

Conclusion

This study further confirms the increased danger of growing vegetables on soils irrigated with contaminated industrial and domestic wastewaters. However, the levels of the metals are currently within the NAFDAC safe limits guidelines. But, if the practice of treating the soils in the irrigation gardens with contaminated waters is not controlled, it may lead to health hazard on the part of consumers of the vegetables on the long term. Therefore, there is the need to continually monitor, control and take necessary policy decisions so as to limit and ultimately prevent these avoidable problems.

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