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Full Length Research Article

BIOACCUMULATION OF HEAVY METALS IN *AMARANTHUS SP.* L SOLD AT VEGETABLE FARMS IN KATSINA METROPOLIS

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ABSTRACT
The study was design to assess the bioaccumulation of heavy metals in spinach sold at vegetable farms at Katsina metropolis, using Atomic absorption spectrometer VPG 210 model for the metals analysis.The study reveals that cadmium has recorded highest concentration followed by chromium and zinc, at Kofar Marusasite, Cd 12.5±2.5mg/kg > Cr & Zn both had 4.7±0.62mg/kg, while Kofar Durbi site Zn 13.2±4.21mg/kg > Cd 12.5±2.5mg/kg > Cr 4.71 ± 0.62mg/kg. Similarly, at K/Sauri, study site, Zn had 13.2±4.21mg/kg > Cd 12.5± 2.5mg/kg > Cr 4.71±0.62mg/kg. However, concentrations of heavy metals in the soil of the study sites show Cr had high mean value of 10.19±0.41mg/kg > Zn 6.13± 0.87mg/kg > Cd 5.84±0.83mg/kg: Plant concentration factor (PCF) in the study ranges between 1.40-2.8Mg/l at K/marusa for Cd, Cr and Zn, K/Durbi 0.45-2.11 and K/Sauri with 0.3-4.0 respectively. Therefore, the study recommended that measures should be taken inorder to mitigate improper discharge of untreated wastewater by the neighboring factories which might be the potential source of contamination of soil and vegetable in the farms.

Keywords: Bioaccumulation, Heavy metals, *Amaranthus sp.* L, Katsian metropolis and Wastewater

INTRODUCTION

Metals are widely distributed in the environment; some are important component of human nutrition. Heavy metals are important group of pollutants. They are non-biodegradable, hence are not readily detoxified and removed by metabolic activities once they are available in the environment. Bioaccumulation of these heavy metals in plants, humans and other animals results in metal poisoning (Audu and Lawal, 2005). Metals may enter the food chain from soil through mineralization by crops or environmental contamination, as in application of agricultural inputs such as pesticides and fertilizers or in the treatment of soils with sewage sludge cupper content of normal plant tissue (Walsh, 1971). Lead is toxic to plants at concentration range of 3-20ppm depending on plants species to animals at a concentration of 1mg/day and human at 10g/day (Bowen, 1979). Zinc is an essential element involved in metabolic functions and important for both human and plant health growth (Jeffery, 1992). Acute Cadmium intoxication is a potentially fatal, but very rare event (Bronstein, 2012). Chronic exposure to Cadmium presents a larger threat to human health (Thevenoed, 2013).

Major factors governing toxicity of chromium compounds are oxidation state and solubility. Chromium (Vi) a powerful oxidizing agent irritant and is a corrosive agent, appeared to be much more toxic systemically than Cr(iii) compounds (ATSDR 2000). Iron replaces other vital minerals such as zinc, copper, manganese and many other in hundreds or even thousands of enzymes binding sites, which cause the enzymes to malfunction and lead to many physical and emotional symptoms (Utah, 2010).

Leafy vegetables accumulate higher metal contents than others (Al Jassir *et al*., 2005). The levels of heavy metals like lead, cadmium, zinc, chromium, iron, nickel etc., were examined in selected fruits and vegetables sold in local markets of Egypt (Radwan and Salama, 2006). Katsina metropolis like any other developing cities of the world is a city where so many consumers of Spinach and other vegetables visit to make daily purchases.

This study was designed to assess some heavy metals accumulation in Spinach sold at vegetable farms in Katsina and compare the level of the trace element with the guidelines set by join WHO/FAO.

MATERIALS AND METHOD

Study Area

The study area is Katsina Metropolis located at latitude 12° 15' and longitude 7° 30' east the capital city of Katsina state, Nigeria.Katsina is located some 257km east of the city of Sokoto, and 135km northwest of Kano, close to the border with Niger. Its population is approximately 5,801,584 (NPC, 2006) and it accounts for 4.1% of Nigeria's total population. The region is mainly populated by the Hausa and Fulani people. Minority groups include the Maguzawa and a considerable number of Yoruba and Igbo people who migrated from southern Nigeria. About 95% of the population of Katsina State is into subsistent agriculture. This involves the production of livestock and also food and cash crops which happens all year round due to irrigation practices made possible along rivers and dams across the state.

Study sites

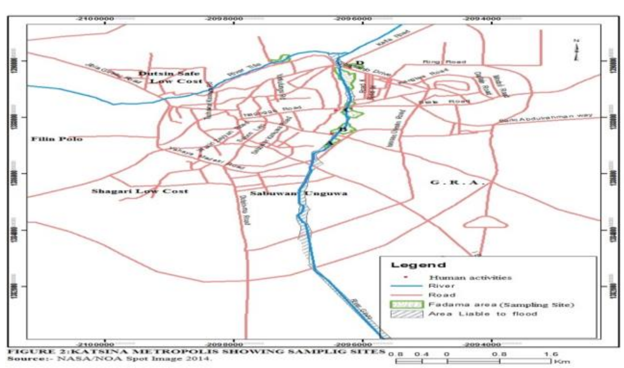

Figure1. Map of Katsina Metropolis Showing the Study Sites
Source: NASA/NOA Space Image 2014

The study sites are Kofardurbi K/Ddurbi),Kofarmarusa(K/marusa) and Kofarsauri(K/sauri) areas.

K/Marusa: is located on latitude 12˚59'19.75"N and 7˚37'00.87"E popularly called 'LambunSarki'. The area is characterized by metal workshops, vehicle repairs centers, and filling stations and it's the catchment area of Katsina oil mill Ltd.

K/Durbi: the area is located on latitude 12˚59'44.10"N and 7˚37'00.73E, although the area for farming of vegetable is quite small, but the vegetable cultivation throughout the year is the main occupation of farmers of this area. Waste water of urban effluent is the major source of irrigation water.

K/Sauri: its located on latitude 13°00'26.92"N and 7˚36'55.87"E, Waste water of urban effluent is major source of irrigation, varieties of vegetables are grown here throughout the year.

Sample Collection and Treatments

A total of (18) eighteen samples of spinach and soil were collected monthly from the three study areas (K/durbi, K/marusa and K/sauri) designated as A, B and C respectively in three Samples were taken from each . At each point, three samples of Spinach (*Amaranthus*sp. L) Were picked. The samples were washed with fresh water in order to eliminate the dust and microbes. The cleaned samples were then air dried in an electric oven at 60º for 24hrs. The dried samples were homogenized by grinding in a ceramic coated grinder (WHO, 2000). The dried samples were stored in a clean polythene bag prior to digestion.

Digestion of Plant Sample

Nitric-perchloric acid digestion procedure recommended by the (AOAC, 1990) was adopted. One gramme of the sample was placed in a 250ml digestion tube and 10ml of conc. HNO_3 was added. The mixtures were boiled gently for 20-45 minutes to oxidize all easily oxidizable matter. After cooling, 5ml of 70% $HClO_4$ was added and the mixture boiled gently until the dense white fume appeared and allowed to cool. After cooling, 20ml of distilled water was added and the mixture was boiled further to release any fumes. The solution was then cooled, further and filtered through Whattman No. 42 filter paper and 0.45µm Millipore filter paper and then transferred quantitatively to a 25ml volumetric flask by adding distilled water, then taken for AAS analysis.

Digestion of soil sample

The soil sample was digested using the procedure by Awode *et* al*.,* (2008). The soil was sieved and 5g of it was used. Three-ml of 30% hydrogen peroxide was added into the beaker (100ml) which was allowed to stand for 60mins up to the time when vigorous reaction stopped. Addition of 75ml of 0.5m solution of HCl was done followed by heating gently on hot plate for 2hrs, the heated solution was cooled and filtered with Whatman No.42 filter paper and the filtrate was taking for AAS analysis.

Plant concentration factor (PCF)

Bioconcentration factor or plant concentration factor (PCF) is a parameter used to describe the transfer of trace elements from soil to plant Edible parts. It is calculated as the ratio between the concentration of heavy metals in the vegetables and that in the corresponding soil all based on (dry weight) for each vegetable separately (Liu *et al.,* 2006).

Bioconcentration factor or Plant concentration factor = Concentration in plant / Concentration in soil
Where, C_{plant} and C_{soil} represents the heavy metal concentration in extracts of plants and soils on a dry weight basis respectively.

Satistical Analysis

Pearson's correlation analysis reveals a strong negative relationship exist (-0.669) between iron concentration in Spinach and wastewater and also Analysis of va.

RESULTS

Heavy metals concentrations from three different sampling sites were recorded as shown in Table 1.0 in which Cadmium recorded highest concentration at in the study sites 15.8±3.84Mg/l-12.5±2.5Mg/l. Zinc was second with values ranges from 14.58±2.76Mg/l-11.11±4.70Mg/l. Chromium was the least with values range of 14.58±2.76Mg/l-3.62±0.63Mg/l. Also the Plant Bioconcentration Factor (BCF) was recorded in the study with Cadmium being the highest concentration factor of 4 at Kofar Sauri Study site as shown in Table 3.0.

Table 1.0 Average Heavy Metal Concentration in Spinach at the study sites.

Study sites	Cd (mg/kg)	Cr (mg/kg)	Zn (mg/kg)
K/Marusa	15.8±3.84	14.58±2.76	14.58±2.76
K/Durbi	12.50±2.5	4.71±0.62	13.2±4.21
K/Sauri	16.67±1.44	3.62±0.63	11.11±4.70

Table 2.0 Average Heavy Metal Concentration in Soil at K/Marusa,K/Durbi and Kofarsauri**.**

Metals	K/Marusa(mg/kg)	K/Durbi(mg/kg)	K/Sauri (mg/kg)
Cd	6.67±0.83	6.67±0.83	4.17±0.78
Cr	10.42±0.41	10.42±0.41	9.72±0.53
Zn	5.21±0.87	6.25±0.6	6.94±0.82

Table 3.0 Plant Concentration Factor at K/Marusa,K/Durbi and Kofarsauri

Metals	K/Marusa (mg/kg)	K/Durbi (mg/kg)	K/Sauri (mg/kg)
Cd	2.37	1.87	4.00
Cr	1.40	0.45	0.37
Zn	2.80	2.11	1.60

DISCUSSION

The results of this study has revealed that generally the concentration of the metals in spinach are in the order of Cd<Zn<Cr. Accumulation of these metals could be attributed to the use of effluents having low magnitude of mentioned metals for uptake and translocation by vegetable crops. Ramraj *et al.*(2000), Demirezem and Aksoy (2006), Farooq*et al.* (2008) and Zuang *et al.*(2009) have also noticed the same observations. The maximum accumulation of cadmium is(15.83mg/kg), which exceeded the WHO/FAO limit by approximately eight, five and four times which

was lower than the vegetables from Titagrah west Bengal, India (17.79mg/kg) (Gupta *et al.,* 2008) and the vegetables from endemic upper gastrointestinal region of Turkey (25mg/kg) (Turkologan *et al.,* 2002), and very higher than that the vegetables from China (0.73mg/kg) (Liu *et al.,* 2005) and significantly more than the vegetables from Egypt (0.008mg/kg) (Dogheine*t al.,* 2004).

The higher concentration of Zn (14.58mg/kg) was found in the samples collected from K/Marusa garden, which may be correlated with the source of irrigation water used in the region. K/Marusa farmers utilize wastewater for irrigation, which contain higher amount of Zn (25-20.83Mg/l). The finding of the present research is similar with the study carried out by Kashif *et al.,* (2009), who studied heavy metals status and their uptake by vegetables in adjoining areas of Hudiara drain in Lahore. The acute exposure of zinc can cause tachycardia, vascular shock, dyspeptic nausea, vomiting, pancreatic disorder, diarrhea and damage of hepatic parenchyma (Salgueiro *et al*., 2000; Ward *et al.,* 1995). The Maximum level of zinc tolerance for human health is 20 Mg/kg according to Chinese Department of Preventive Medicine (1995)

The Bioconcentration factor (Table 5.0) of cadmium (4.0) at K/Sauri and zinc (2.80) at K/Marusa was the highest value recorded which was supported by the observation of Liu *et al.*(2006). The trend of Bioconcentration Factor of heavy metals in the vegetables of this study were Cd>Zn>Cr, this is more or less similar to result reported by Khan *et al.* (2008).

Conclusion

The concentration of the metals in this study indicate thatall are above the safe limit set by WHO/FAO guidelines (2006), statistically the data shows significant difference $P<0.05$ in their concentrations.The data generated in this study must be used as baseline wastewater quality framework to serve as a basis for monitoring irrigation water quality in Katsina Metropolis, also **g**overnment should provide alternative water source to the affected populace. Measures should also be taken to minimize heavy metals pollution in irrigation water.

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