



Heavy Metals Accumulation in Vegetables from Irrigated Farmlands in Tudun Wada Zaria Metropolis, Kaduna State, Nigeria.

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ABSTRACT

The levels of some heavy metals were investigated on five (5) selected vegetable samples, two leafy vegetables: Spinach (*Amarantus spp*), Lettuce (*Lactuca sativa L.*); two solanaceous vegetables: Tomato (*Lycopersicum esculentum*), Ball (Red) pepper (*Capsicum annum Linn*) and one root vegetable: Onion (*Allium cep L.*) that were freshly harvested within two different irrigated farmland in Tudun-Wada, Zaria Local Government Area of Kaduna state. The levels of the heavy metals, (Pb, Cd, Cr, Cu, Zn and Fe) were analyzed using Atomic Absorption Spectrophotometer (AAS) (Buck model 210 VGP). In all the samples analyzed, Cd and Cr were not detected. The levels of heavy metals analyzed, the results ranged from Pb (0.056 ± 0.009 mg/kg to 0.095 ± 0.010 mg/kg), Cu (0.314 ± 0.043 mg/kg to 0.632 ± 0.022 mg/kg), Zn (1.090 ± 0.170 mg/kg to 8.341 ± 4.070 mg/kg) and Fe (9.926 ± 2.226 mg/kg to 23.660 ± 4.135 mg/kg). The order of the metal contamination in the vegetables was Fe>Zn>Cu>Pb. The results were below the WHO/FAO threshold values. The consumption of these vegetables as food may not pose possible health hazards to a human at the time of the study.

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INTRODUCTION

In a recent development, Agriculture plays a major role in the growth of the Nigerian economy which controls a lot in the country's GDP. Vegetables are important edible crops that are an essential part of the human diet. They are highly nutritious and also an important source of carbohydrates, vitamins, and fibres (Hu, Wu, Wu, Cao & Wong, 2013). The demand for food continues to grow as a result of population growth which leads to increase the use of pesticides, fertilizers manures as well as the use of wastewaters for irrigation, in that regard contaminate the crops with heavy metals.

Heavy metals contamination of agricultural soil could pose long term

environmental problems and could also cause health hazard to man and other living organisms, as their bioaccumulation in the food chain can be dangerous to human health. Heavy metals enter the human body through inhalation and ingestion, the latter being the main route of exposure to these elements in the human population (Funtua, Agbaji & Ajibola, 2008).

Minor and trace elements that are from organic or plant source are from an organic or plant source are essential for good health but those from an inorganic or metallic source becomes toxic (Bagdatlioglu, Nergiz & Ergomul, 2010). The process of plant growth depends on the cycle of nutrients including trace elements, from soil to plant (Mohamed, Rashed &



Mofty, 2003). Vegetables, especially leafy vegetables, accumulate higher amounts of heavy metals because they absorb these metals in their leaves.

Lead (Pb) and Cadmium (Cd) are regarded as toxic and are related to so many diseases. Consumption of a high amount of Pb can affect the intelligence development of children, can also cause hypertension and cardiovascular diseases (Ekong et al. 2006; Navas-Acien et al. 2007). Also, excess Cd exposure can lead to impaired function of the immune system and can also lead to damage in the liver and lungs (Goyer, 2003; Klassen, Liu & Diwan, 2009)

Elements like Copper (Cu), Zinc (Zn) and Iron (Fe) are more essential nutrients in the human diet, but excessive intake can also have adverse effects on human health. For example, Cu surplus can lead to damage in liver and can also cause acute stomach and intestine aches (Gaetke, 2003; Rahman, 2014) and Zn can reduce immune function and levels of high-density lipoproteins (Harmanescu, 2011; Zhou, 2016).

This work aims to investigate the content of heavy metals (Pb, Cd, Co, Cu, Zn and Fe) in vegetable samples from some irrigated farmlands around Tudun - Wada area of Zaria Local Government Area of Kaduna state, Nigeria.

Description of the Study Area

Tundun-Wada is a suburb of Zaria Metropolis; Zaria is a city in Kaduna, Nigeria. It is located at 11.11⁰N latitude and 7.72⁰ E longitude and it is situated at elevation 644 meters above sea level. Zaria has a population of 975,153 (2002 census) making it the 2nd biggest city in Kaduna.

Sampling

Five different vegetable samples were collected as follows; two leafy vegetables: Spinach (*Amaranthus* spp),

Leafy lettuce (*Lactuca sativa* L.); two solanaceous vegetables: Tomato (*Lycopersicum esculentum*), Ball (Red) pepper (*Capsicum annum* Linn) and one root vegetable: Onion (*Allium cepa* L.) were collected from two farms in the study area. The research was carried out on vegetable samples collected from irrigated farmlands around Zaria metropolis between October and November 2018. The samples were collected from farm sites/locations in Tudun Wada Area.

Table 1.1: Vegetable Samples with their local and Botanical Names

Vegetable name	Local name (Hausa)
Botanical name	Vegetable type
Spinach	Alayyahu
<i>Amarantus</i> spp Leaf	
Lettuce	Latas
<i>Lactuca sativa</i> L.	Leaf
Tomato	Tumatur
<i>Lycopersicum esculentum</i>	Solanaceous
Bell pepper (Red)	Tattasai
<i>Capsicum annum</i> Linn	Solanaceous
Onion	Albasa
<i>Allium cepa</i> L.	Root

Sample Treatment

Samples were taken to the laboratory, washed under tap water to remove sand. They were then rinsed with de-ionized water and dried in an oven at 60°C for 2hours. Samples were then pulverized using mortar and pestle and passed through 2mm sieve.

Sample Digestion

Vegetable samples were digested by weighing 1.0g of each sample in 250cm³ beaker and adding a mixture of HNO₃ and HCl (3:1). The sample was digested on a hot plate until a clear solution was obtained, cooled and a little amount of distilled water added. It was filtered through Whatman filter paper No. 1 into 50cm³ volumetric flask. The solution was then made up to the



mark with distilled water and transferred into a clean plastic bottle.

Sample Analysis

A serial dilution method was used to prepared the working standards the concentrations of the metals in each sample digest were determined using Alpha 4 Chem Tech Analytical Atomic Absorption

Spectrophotometer (Buck model 210 VGP) equipped with a digital readout system at the Multipurpose Laboratory Complex Ahmadu Bello University Zaria, Nigeria.

Statistical Analysis

Data obtained were analyzed using Microsoft Excel and results were expressed as mean \pm standard deviation.

Table 2.1: Concentrations of some heavy metals in vegetable samples (in mg/kg)

Vegetable	Pb	Cd	Cr	Cu	Zn	Fe
Spinach	0.095 \pm 0.010	ND	ND	0.483 \pm 0.018	8.341 \pm 4.070	23.660 \pm 4.135
Lettuce	0.071 \pm 0.022	ND	ND	0.333 \pm 0.034	2.570 \pm 0.730	20.811 \pm 4.543
Onion	0.056 \pm 0.009	ND	ND	0.632 \pm 0.022	2.411 \pm 0.540	14.510 \pm 2.811
Tomato	0.078 \pm 0.023	ND	ND	0.314 \pm 0.043	1.090 \pm 0.170	9.926 \pm 2.226
Ball pepper	0.078 \pm 0.023	ND	ND	0.481 \pm 0.130	1.419 \pm 0.185	11.790 \pm 1.688
Range	0.056-0.095	-	-	0.314-0.632	1.090-8.341	9.926-23.660
FAO/WHO safe limit	0.30	0.20	2.3	73	99.4	425

RESULTS AND DISCUSSION

Lead

Lead, Pb is highly toxic to human and animals. The plants usually accumulate large amount of Pb without visible changes in their appearance or yield. Pb is a neurotoxin that can affect almost every organ or system in the human body. It can reduce cognitive development and intellectual performance in children and also damage kidneys and reproductive system.

The study recorded the level of Pb concentration ranged between 0.056-0.095mg/kg. Pb maximum concentration of 0.095mg/kg was recorded in Spinach and lowest 0.045mg/kg was seen in Ball pepper. This concentration did not exceed standard limit 0.30mg/kg. Our findings are parallel with previous study conducted by Akan et al. 2013 whose work recorded Pb concentration in vegetables ranged from 0.87 to 8.34mg/kg with spinach and onion with the highest (8.34mg/kg) and lowest (0.87mg/kg) concentrations respectively. However all the vegetables in terms of Pb

concentration did not elevate the safe limit of FAO/WHO safe limit. Pb values (in mg/kg) in the vegetables were in the following sequence: Spinach (0.095) > Tomato (0.078) > Lettuce (0.071) > Onion (0.056) > Ball pepper (0.045).

Cadmium and Chromium

Cadmium, Cd is one of the heavy metal poisons that is not known for any essential biological function in plants. Cd is present as an impurity in several product including phosphate fertilizers, detergents and refined petroleum products. Cd is very biopersistent, in the body is known to affect several enzymes, renal damage that result in proteinuria.

Chromium, Cr is one of the less common elements that are also toxic to plants and animals. Cr does not occur naturally in elemental form, but only in compounds. Cr is associated with allergic dermatitis in humans.

In the present study, no concentration of both Cadmium and Chromium was detected in all the samples



which conform to the study of Alexander and Ubandoma, (2014) on their work on heavy metals on vegetables grown along River Yedzaram in Uba area in Adamawa. This may be as a result of Tudun Wada, Zaria is not an industrial city. Industries are the main source of Cd and Cr (Raphael & Adebayo, 2011).

Copper and Zinc

Copper, Cu is an essential micronutrient which functions as a biocatalyst required for body pigmentation. However, most plants contain the amount of Cu which is insufficient for ordinary development but can be enhanced with the essential or organic fertilizers. The level concentration of Cu is of the range 0.314mg/kg-0.632mg/kg. Onion has the highest concentration with 0.632mg/kg and the lowest was seen in Tomato at 0.314mg/kg. The results conformed to the values obtained for 0.87mg/kg and 0.72mg/kg in Onion and 0.301mg/kg and 0.25mg/kg for Tomato as reported by Ladipo, (2011) and Mayuri, Munjal, Nema, Gupta and Kausal, (2016). All the vegetable concentration of Cu did not elevate the safe limit of FAO/WHO. Onion (0.632) > Spinach (0.483) > Ball pepper (0.481) > Lettuce (0.333) > Tomato (0.314).

Zinc, Zn is an essential nutrient in humans and animals and is necessary for the function of enzymes. The Zn content was measured in the range of 1.09mg/kg-8.341mg/kg. Spinach has the highest concentration of 8.341mg/kg while the tomato has the lowest concentration of 1.09mg/kg. The concentration values are below the safe limit of FAO/WHO which is in agreement with the investigation of heavy metals by Adah, Abah, Ubwa and Ekele, (2013) on vegetables cultivated at the bank of River Benue with the average content of Zn to be 8.21mg/kg. Spinach (8.341) > Lettuce (2.570) > Onion (2.411) > Ball pepper (1.419) > Tomato (1.090).

Iron

Fe is an essential element to both plant and humans. It acts as a catalytic centre for a broad spectrum of metabolic functions and also a component of various tissue enzymes. Its deficiency includes symptoms such as reduced resistance to infection, reduced work productivity, physical fitness, weakness, fatigue and reduced learning ability. Deficiency of Fe in developing countries like Nigeria is reported by several studies (Funtua, Agbaji & Ajibola, 2008; Ladipo & Doherty, 2011; Raphael & Adebayo, 2011). The present study shows that the level of Fe in vegetables was found in the range 9.926 - 23.660mg/kg. The result conforms to previous works of Singh, Sharma, Agrawal and Marshal, (2010); Ukpabi, Chinwendu, Emmanuel, Ifeanyi, Micheal and Nduleka, (2016) where the concentration of Fe in spinach and lettuce where found to 19.45mg/kg and 28.43mg/kg respectively.

The high concentrations of iron in vegetables could be attributed to the role of iron chlorophyll synthesis in plants in addition to relative abundance as native iron as reported by many authors (Funtua, Agbaji & Ajibola, 2008; Mohammed, Rashed & Mofty, 2003; Ukpabi, Chinwendu, Emmanuel, Ifeanyi, Micheal & Nduleka, 2016).

CONCLUSION

The mean values show that leafy vegetables like Spinach and Lettuce have the high heavy metal concentration of Pb, Zn and Fe than other vegetables. According to Latif, Bilal, Asghar, Azeem and Ahmad, (2018) is the ability of high absorption rates of leafy vegetables bearing a large surface area than other vegetables.

The study has shown that all the vegetables analysed (Pb, Cd, Cr, Cu, Zn and Fe) have valued below the WHO/FAO recommendation safe limit that can cause toxicity in plants.



Agricultural activities such as application of fertilizers and other chemicals, use of waste or polluted water for irrigation can affect bioavailability and crop accumulations of heavy metals. Continuing farmer's education on such practice can go a long way in maintaining the established safe limits of heavy metals in vegetables.

Consumption of these vegetables as food may not constitute possible health hazards to humans at the time of study.

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