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Analysis of Some Heavy Metals Present in Spinach Leaves Obtained from Selected Irrigation Sites of Katsina and Ajiwa Towns, Katsina State

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Abstract
This research work focuses on the evaluation of heavy metals contained in the vegetable (spinach) found in some selected areas of Katsina senatorial zone. The consumption of contaminated vegetables may cause health hazardto both human beings and animals. This study therefore investigated the level of four different heavy metalsthat are essential but their higher concentrations considered toxic: such metals are copper (Cu) chromium (Cr), cadmium (Cd) and zinc (Zn). The area covered in this work involved Ajiwa, Kofar Durbi and Kofar Sauri irrigation sites. The spinach obtained was purified, dried and analyzed using atomic absorption spectrophotometer (A.A.S). All the heavy metals were found to be below the approved limits of World Health organization and Food and Agricultural Organization (W.H.O/F.A.O) with the exception of Cd. The results indicate that the levels of essential elements (Cu, Cr, Cd and Zn) contained in the vegetables used were lower than the published threshold values for metal toxicity in mature plant tissue. The outcome of this research therefore, recommends the identification of Cd source from these irrigation sites so as to curtail its infiltrations in the vegetables grown.

Keywords: Heavy Metals, Irrigation, Leaves, Spinach, Spectrophotometer

INTRODUCTION
The problem of environmental pollution due to toxic metals has been and is continuously becoming an issue of concern in most metropolitan cities (Salawu *et al.,* 2015).The use of water from non-conventional sources like polluted water of industrial and household discharge is a common practice in most African countries that are facing problems of water shortage (Al-Ansari *et al.,* 2013).

Heavy metal such as cadmium, lead and zinc are important environmental pollutants, particularly in areas where vegetables are irrigated with waste water. Treatment of crops with wastewater caused increased uptake of heavy metals, namely Fe, Mn, Pb, Cd, Cr, Cu, and Ni, in cauliflower, mustard, radish, celery, spinach etc. (Gupta *et al*., 2008) Consumption of

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contaminated vegetables such as spinach by humans and animals has been reported to pose serious health hazards. Although some heavy metals such as lead, cadmium and magnesium are important in plant nutrition, many of them do not play any significant role in plants physiology. The uptake of these heavy metals especially into the human food chain is done through these leafy vegetables and these have been found to have harmful effects on the health (Jarup, 2003).

Heavy metals which are harmful to humans generally include cadmium, chromium, copper, mercury, lead, zinc, iron, arsenic, cobalt, nickel etc. These are found naturally in the soil in minute amounts, and in industrial waste water due to different chemical processes such as precipitation, filtration, ion exchange etc. They are normally found in limited amounts or above the permissible limit which causes few problems (Halnor, 2015).

Many water sources such as lakes and rivers comprise wastes like heavy metals, sewage, fertilizers, decaying animals, industrial pollutants and other waste materials. All these have been proven to be hazardous to the aquatic ecosystem (Halnor, 2015). The environmental problems due to globalization and speedy industrialization are becoming disadvantageous to human beings due to increase in pollution. Heavy metals present in wastewater and industrial effluent are major concerns of environmental pollution. They are generally considered as those metals whose density exceeds $5g/cm^3$ (Gunatilake 2015). The maximum permissible limit standard for copper, lead, cadmium, iron and chromium are 1.00, 0.01. 0.003, 0.30 and 0.05mg/L respectively (Babel and Kurniawon, 2003; SON, 2015).

The implications associated with metal (embracing metalloids) contamination are of great concern, particularly in agricultural production systems (Kachenko and Singh, 2006) due to their increasing trends in human foods and environment. These metals pose as a significant health risk to humans, particularly in elevated concentrations above the very low body requirements (Gupta *et al.,* 2008). Hence, the metals must be controlled in food sources in order to assure public health safety (WHO, 1995). Excessive amount of heavy metals in food cause a number of diseases such as cardiovascular, renal, neurological, and bone diseases (Chailapakul *et al.,* 2007). The contamination of soil and vegetables by heavy metals is a global environmental issue (Tasrina *et al.,* 2015). Under certain environmental conditions, these metals may accumulate to toxic concentration and can cause ecological damages (Jofferies, 1984; Freedman, 1989).

The uncontrolled irrigation of crops with sewage water leads to the accumulation of some potentially toxic metals in agricultural soil and have very adverse effects on the growth of the plants (Muhammad *et al.,* 2013). It is now a common practice in many parts of Nigeria to use municipal sewage water that contain both industrial effluents and domestic liquid waste for irrigation purpose (Alexander and Ubandoma, 2014; Odoh and Adebayo, 2011). And after that vegetables take up metals by absorbing them from contaminated soil as well as fromdeposits on different parts of the vegetables exposed to the air from polluted environments (Oluwole *et al.,* 2013).

Leafy vegetables occupy a very important place in the human diet, but unfortunately constitute a group of food which contributes maximally to nitrate and other anions as well as heavy metal consumption (Zurera *et al.,* 1999). Spinach just like other vegetable plant are used as food and constitute an important part of the human diet because it is rich in carbohydrate, protein, as well as vitamins, minerals and trace elements (Oluwole *et al.,* 2013).

This study investigates the extent of contamination of zinc, cadmium, chromium, and copper in spinach within selected irrigation sites of Katsina and Ajiwa towns and evaluated their contamination status with respect to international food standard guidelines.

MATERIALS AND METHOD

Reagents used for the study were all of analytical grade. The glass wares and plastic containers used in this work were washed with detergent solution followed by nitric acid and rinsed with tap water and finally with distilled water.

Sample collection and treatment

Fresh spinach (*Spinacia oleracea*) was harvested from selected irrigation sites within Katsina and Ajiwa towns, packaged in polyethylene bags and labeled. These were immediately transported to the laboratory. All samples collected were carefully washed with distilled water to remove soil and other impurities, and then dried in an oven at 80°C for 24 hours. After drying, the samples were pulverized using mortar and pestle into fine powder, sieved and kept in air tight containers (AOAC, 2000).

Sample digestion

One gram of each sample was taken into kjeldal digestion flask, mixed with 10cm^3 of aqua-regia (concentrated sulphuric acid, concentrated perchloric acid and concentrated nitric acid in the ratio 1:2:20 respectively) and left to stand overnight. There after the flask was heated at 70°C for 40 minutes after which the temperature was raised to 120°C. The mixture turned black after 10 minutes and the heating was continued until a clear solution was obtained which produced white fumes. The digest was diluted with 20cm^3 of distilled water, boiled for 15minutes, allowed to cool and then transferred into 100cm^3 volumetric flasks and diluted to the mark with distilled water. The sample solution was then filtered using a filter paper in a screw capped polyethylene bottle and finally, the samples were taken for atomic absorption spectroscopy (AAS). (Chavhan *et al.,* 2018)

Statistical analysis

The results obtained were analyzed using IBM SPSS v23*64 to determine the ANOVA at 95% confidence limit.

RESULT

Table 1: Concentration of heavy metals (mg/kg) in spinach obtained from selected irrigation sites

S/N	METALS	AJIWA	KOFAR SAURI	KOFAR DURBI	WHO/FAO LIMIT
1	ZINC (Zn)	1.39±0.18	4.16±0.16	2.76±0.16	99.40
2	CADMIUM (Cd)	15±0.5	10±0.33	15±0.5	0.20
3	CHROMIUM (Cr)	1.85±0.25	3.71±0.23	5.56±0.67	2.30
4	COPPER (Cu)	27.27±1.18	250±4.33	22.73±0.18	73.00

Mean ± SD (Standard deviation)
Analyzed using IBM SPSS v23*64 at 95% confidence limit.

DISCUSSION

The spinach leave was obtained from three irrigation sites viz; Ajiwa, Kofar Sauri and Kofar Durbi respectively. The samples were digested and analyzed for heavy metal determination using atomic absorption spectrometer (A.A.S).The concentration of heavy metals in spinach from Ajiwa irrigation site had the highest content of Cu, followed by Cd, Cr, and Zn as shown in Table 1. All the heavy metals were found to be below the approved limit of W.H.O/F.A.O

except cadmium which was found to be 0.5mg/kg while its safe limit is 0.20mg/kg.This higher concentration of cadmium in Ajiwa irrigation site may be attributed to the soil composition or the rivers (channels) linked to the dam. Cadmium is relatively mobile in soil under a range of pH, organic carbon and cation exchange capacity condition (Odoh and Adebayo, 2011). The spinach grown at this irrigation site could be safe for consumption if the cadmium source is identified and controlled. Moreover, the other essential elements should also be controlled to meet the daily elemental requirement of Zn, Cu, Cd and Cr that has the value of 60mg/day, 0.7-1.0mg/day, 16-30µg/day and 25µg/day of Zn, Cu, Cd and Cr respectively (W.H.O 1996).

The heavy metals (Zn, Cd, Cr and Cu) determined in Kofar Sauri irrigation site were found to be below the permissible limit given by W.H.O/F.A.O except cadmium whose level was 0.33mg/kg and above the permissible limit. This higher value of cadmium in Kofar Sauri irrigation site may be due to municipal refuse disposal along the water channels leading to the irrigation site. Municipal refuse may contain paper, food wastes, metals, glass, ceramics and ashes. Studies have shown that these wastes can accumulate heavy metals which can persist in soil at environmentally hazardous level (Salawu *et al.,* 2015).Spinach grown in this area can be safe for consumption if there is good environmental sanitation, use of borehole waterfor irrigation, banned use of contaminated stream and/or good soil analysis to confirm the source of the heavy metals for proper control.Considering the daily requirements of 60mg/day, 0.7-1.0mg/day, 16-30µg/day and 25µg/day of Zn, Cu, Cd and Cr respectively reported by W.H.O in 1996, spinach can be a good supplement that will provide some balances in the uptake of these metal ions to the body.

However, the result of heavy metal concentration in the spinach obtained from Kofar Durbi irrigation site is shown in Table 1. The sample from this site reveals lower levels of these metals (Zn, Cr, and Cu) when compared with the WHO/FAO dosage level. While cadmium have concentration of 0.5mg/kg which was above the permissible limit provide by W.H.O/F.A.O. This may be attributed to the indiscriminate dumping of domestic and industrial wastes on the water channels that passes through the farm landwhich may subsequently be absorbed by the vegetable (spinach) grown in the area. Plants watered with the wastewater are usually contaminated with heavy metal and pose health concern. The accumulation of heavy metals such as Fe, Mn, Cu, Zn and Pb in plant significantly increases by sewage water irrigation (Mohammed *et al.,* 2014). Similar work reported by Akan *et al.,* (2009), observed that vegetables accumulate considerable amount of heavy metals especially Pb, Cr, Cu, and Zn in roots and leaves.

CONCLUSION

The levels of some of the heavy metals determined were within the approved limits international agencies (WHO/FAO). However, the practice of irrigating the vegetables with contaminated water should be controlled and proper soil and vegetable analysis should be conducted regularly to ensure that the amount of heavy metals contained is within the admissible limit. This will assist in curtailing the menace of possible health hazard to the consumers on long term basis.

Therefore, there is the need to continually monitor, control and promulgate a policy on the use of waste water for irrigation purposes. However, farmers from the study areas are hereby encouraged to use well water for irrigation purposes instead of contaminated stream.

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