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DETERMINATION OF HEAVY METAL CONCENTRATION OF SOME VEGETABLES GROWN AT AJIWA FARM IN BATAGARAWA LGA IN KATSINA STATE

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ABSTRACT

The level of heavy metals (Cd, Co, Cr, Ni, Fe, and Pb) in spinach, green beans and onions were determined using Atomic Absorption Spectrophotometer methods (AAS) (Buck Scientific Model 210VGP). The plant samples were collected from Ajiwa farm a few kilometers from Katsina metropolis and similar plant samples from Iyaka farm which served as control. The results of the analyzed samples obtained from Ajiwa indicated that the samples were generally free from heavy metal contaminations as set by World Health Organization (WHO) standard except cadmium which was above the recommended level. The values of all the metals analyzed with respect to Ajiwa were higher than those from the control site (Iyaka farm). Therefore there is need for further monitoring since the people of the area depends on the farm for farming activities.

INTRODUCTION

Food is any substance consumed to provide nutritional support for the body. It is usually of plants or animal origin and contains essential nutrients such as carbohydrates, fats, proteins, vitamins and minerals. Such a substance is ingested by an organism and assimilated by the organism cells in an effort to produce energy, maintain life or stimulate growth (Aguilera and David, 1999).

Leafy vegetables are highly beneficial for maintenance of health and prevention of diseases. They contain valuable sources of food ingredients that can be utilized to build up and improve the body successfully (Hanif et al., 2006). They also maintain alkaline reserve of the body, contain high carbohydrate, vitamins and minerals.

Plants constitute important component of ecosystem as they provide the transport pathway from the abiotic to biotic environment. Uptake of elements by the plant reflects their bioavailability in soil and affects

plant yield and crop quality to the extent that animal or human health may be jeopardized (Mingorance, et al 2007).

Pollution is one of the most important problems around the world today in which thousands of millions of world inhabitants suffer health problems related to industry and atmospheric pollutants (Martinez et al., 2001). Heavy metals enter into our environment from both natural and anthropogenic sources (Kabata and Pendias, 1986). They contaminate food source and accumulate in both agriculture products and seafood through water, air and soil pollution. All heavy metals are toxic at soil concentration above normal level. Addition of heavy metals to soil may affect microbial proliferation and enzymatic activities, possibly leading to a decrease in the rates of the biochemical process in the soil environment. Worldwide increasing level of industrialization and urbanization has led to environmental pollution (Filazi et al., 2003).

Ajiwa is a small nucleated settlement, east of Katsina, about 22 Km along the trunk road linking Katsina and Daura. The centre of the town is located on latitude $12^{\circ} 57'$ and longitude $7^{\circ} 46'$ (topographic sheet No 34, Nigeria). A district headquarters of Rural Water and State Sanitation Agency (RUWASSA) Katsina, a traditional title synonymous with water supply. (KTARDA, 2002).

This work is aimed at determining the levels of heavy metals in some vegetables cultivated at Ajiwa farm in Batagarawa Local Government Area in Katsina State. And comparing the results obtained with the National and World standards

MATERIALS AND METHODS

Sample Collection

Samples of spinach, Onion and Green beans were collected (at 5 different points) using random sampling method from various gardens plots farm. These were packed in polythene bags, labeled and transported to the laboratory. The sampling was done at different time intervals (at early stage, middle of growth and at maturity).

The plant samples were identified at the herbarium section of the Department of Biological Sciences of Umaru Musa Yar'adua University, Katsina.

Digestion is primarily used in the preparation of samples for subsequent analysis for specific minerals. It breaks down and removes the organic matrix surrounding the minerals so they are left in the aqueous solution (McLaughlin *et al.*, 1999). The digestion mixture was made up of trioxonitrate (V) acid (Sg. 1.42; purity 70.5%, A.R), Concentrated perchloric acid (vii) acid (72% A.R) and concentrated tetraoxosulphate VI acid (sg. 1.84; purity 98%, A.R) mixed in the ratio acid (70-72% A.R) 5:4:1 respectively (AOAC, 2000). These mixtures were heated on hot plate for 2 hours at 150°C . The mixtures were allowed to cool and filtered into 50 cm³ standard volumetric flask and made up to mark. A blank was also prepared.

Atomic Absorption Spectrometer (AAS) (Buck Scientific Model 210 VGP) was used for the analysis of the heavy metals in the samples.

RESULTS AND DISCUSSION

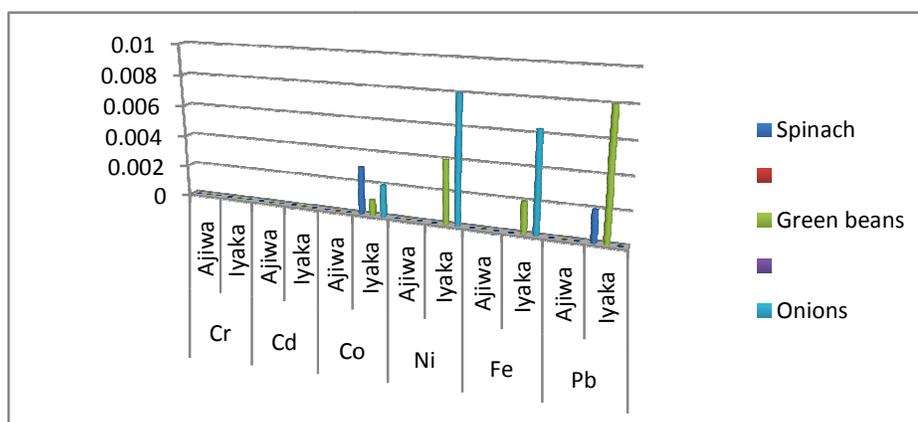
For Ajiwa farm, spinach had $0.164 \pm 0.065 \text{ mg/kg}$, green beans $0.21 \pm 0.017 \text{ mg/kg}$ and onion was $0.121 \pm 0.040 \text{ mg/kg}$. For the control farm, the concentrations of chromium in spinach, green beans and onion were not detected. From the findings, the concentrations of chromium in spinach, onion and green beans samples from Ajiwa farms were above the concentration obtained from control farm. At Ajiwa farm, the concentration of chromium was highest in green beans plant followed by spinach and least in onions. The permissible limit of Chromium for plants is 1.30 mg/kg as recommended by World Health Organization (2008). Comparing the concentration of chromium obtained in this research with the permissible limit, it was observed that the concentrations were all within the range of the permissible limit recommended by WHO (2008). Zaidi *et al.*, (2003) reported 0.09 mg/kg for black beans and 0.13 mg/kg for mung beans. Comparing these values with green beans, it can also be observed that the concentration reported for black beans and mung beans were below that of green beans obtained in this work. Butt *et al.*, (2005) reported 2.95 mg/kg while Niqarunnisa, (1997) reported 1.8 mg/kg for chromium. These reported concentrations for chromium by the above researchers are higher than the obtained values in this present work.

The concentrations of cadmium in plant samples from Ajiwa farm are as follow spinach $0.142 \pm 0.013 \text{ mg/kg}$, green beans, $0.39 \pm 0.048 \text{ mg/kg}$, onion plant sample $0.275 \pm 0.041 \text{ mg/kg}$ respectively. Cadmium was not detected in these samples at the control farm. When compared, the concentrations of cadmium in green beans and spinach plant samples showed that the values for Ajiwa farm were above the control farm. At Ajiwa farm, the highest concentration was recorded in green beans sample followed by the onions plant sample and least in spinach plant. The permissible limit of Cadmium in plant is 0.02 mg/kg as recommended by WHO (2005).

Table 1: Concentrations of heavy metals in plant sample analyzed from Ajiwa

	Cr		Cd		Co		Ni		Fe		Pb	
	Ajiwa	Iyaka	Ajiwa	Iyaka	Ajiwa	Iyaka	Ajiwa	Iyaka	Ajiwa	Iyaka	Ajiwa	Iyaka
Spinach	0.164 ± 0.065	ND	0.142 ± 0.013	0	0.123 ± 0.01	0	0.09 ± 0.011	0.009 ± 0.0001	0.109 ± 0.079	0.009 ± 0.001	0.082 ± 0.00	0.002
Green beans	0.207 ± 0.017	ND	0.703 ± 0.014	0	0.184 ± 0.015	0	0.144 ± 0.026	0.004	0.246 ± 0.016	0.002	0.125 ± 0.047	0.008
Onions	0.121 ± 0.012	ND	0.275 ± 0.41	0	0.085 ± 0.023	0	0.098 ± 0.016	0.008	0.16 ± 0.033	0.0063	0.67 ± 0.0016	0.007 ± 0.001

Key; ND- Not detected



The concentrations of cadmium in all the samples from Ajiwa were above the recommended level for cadmium. This poses a serious health risk to the consumers of such vegetables. For the control farm, the concentration obtained for all the plant samples were below the recommended level. Niqarunnisa, (1997) reported 1.8mg/kg for spinach plant while Butte *et al.*, (2005) reported 2.95mg/kg. By comparison it can be observed that these values were above the obtained values in this work. This could be due to higher cadmium related activities being released into irrigation waters such as impurities from super phosphate fertilizer.

The concentrations of cobalt in spinach, green beans and onion plant samples from Ajiwa farm, were 0.123 ± 0.01mg/kg, 0.081 ± 0.008mg/kg, and 0.085 ± 0.023mg/kg respectively. For the control, the concentration of cobalt in spinach plant

sample was 0.003 ± 0.001mg/kg, green beans sample 0.001 ± 0.0001mg/kg, onion plant sample 0.002 ± 0.001mg/kg respectively.

By comparison, the concentrations of cobalt in the plant samples from Ajiwa farm were above the values obtained from control farm. At Ajiwa farm, the highest concentration of cobalt was recorded in spinach plant followed by onions and least in green beans plant. In the control farm, the highest concentration of cobalt was recorded in onions followed by spinach plant samples and least in green beans plant. The World Health Organization (WHO, 2008) standard for cobalt in plant is 50mg/kg (WHO, 2008) thus, it can be observed that all the results obtained were within range of the recommended 50mg/kg levels, and therefore all the plants samples analyzed can be considered safe for consumption.

The concentration of nickel from Ajiwa farm in spinach, green beans and onions were 0.09 ± 0.011 mg/kg, 0.74 ± 0.066 mg/kg, and 0.098 ± 0.016 mg/kg respectively while that found in control farm, t were 0.009 ± 0.001 mg/kg, 0.004 ± 0.002 mg/kg, and 0.008 ± 0.003 mg/kg respectively. When the above concentrations of nickel were compared, it was observed that the values for the Ajiwa farms were above those from the control farm. On the basis of nickel concentrations in individual plant, spinach had the highest, followed by green beans and least was in onions while in the control farm, the highest concentration for nickel was recorded in spinach plant followed by onions and least in green beans. The World Health Organization standard for nickel in plant is 50 mg/kg (WHO, 2008). So it can be observed that all the results obtained were within range of the recommended levels and therefore all three plants analyzed can be considered safe for consumption. Zaidiet *al.*, (1997) reported 0.26 mg/kg for nickel in black beans and 0.12 mg/kg for mung beans. These values are above those obtained in the study; the differences in the values in both cases may due to lack of industrial activities that increase nickel contamination in the site of preanalyzed and soil used for cultivation. The concentration levels of iron in spinach, green beans and onions samples from Ajiwa farm were 0.109 ± 0.079 mg/kg, 0.22 ± 0.012 mg/kg, and 0.16 ± 0.033 mg/kg respectively, which is 0.009 ± 0.001 mg/kg, 0.002 ± 0.001 mg/kg, and 0.006 ± 0.003 mg/kg, respectively was recorded in the control farm. The results indicated that the concentrations of iron obtained from Ajiwa farm were above that found in the control. The highest concentration of iron was recorded in green beans plant followed by onions and least in spinach plant while from the control farm, the highest concentration of iron was recorded in spinach plant followed by onions and least in green beans plants. The (WHO, 2008) recommended level of iron in plants is 20 mg/kg. All samples in this research were below the recommended level for iron in plant and therefore safe for consumption. Singh *et al.*; (2000) reported 0.029 mg/kg for plant

which is below the concentration obtained in this present work. There was no significant difference ($p > 0.05$) between the concentration of iron in plant analyzed and soil used for cultivation.

The concentrations of lead in spinach, green beans and onions plants from Ajiwa farm were 0.082 ± 0.0 mg/kg, 0.058 ± 0.0 mg/kg and 0.67 ± 0.016 mg/kg respectively. For the control farm, the concentrations of lead in spinach plant were 0.002 ± 0.0 mg/kg, green beans sample 0.008 ± 0.0 mg/kg, onion sample 0.007 ± 0.001 mg/kg. By comparison, the concentrations of lead in the samples obtained from Ajiwa farm were above the values obtained from the control farm. In Ajiwa farm, the highest concentration for lead was found in onion plant sample followed by spinach plant and least in green beans sample. For the control farm, the highest concentration of lead in plant was found highest in green beans sample followed by onion plant sample and least in spinach sample. The permissible limit for lead in plants recommended by (WHO, 2008) is 2.5 mg/kg. The reported concentrations of lead are below the recommended value. Demirezen and Ahmet (2006) analyzed different samples of vegetables and reported a high concentration (3.0-10.7 mg/ Kg) of Pb, which poses health risks to human life. These values were above the values reported in this work. In another study, Sharma *et al.*, (2006) investigated concentration of Pb (17.54-25.00 mg/Kg) in vegetables grown in wastewater industrial areas were found to be above the safe limit (2.5 mg Kg).

These values are above the value reported in this research. Muchuweti *et al.*, (2006) reported the level of Pb (6.77 mg/ Kg) in vegetables irrigated with mixtures of wastewater and sewage from Zimbabwe all these values are above the values reported in this present work.

Wong (1996) reported that heavy metal concentration is higher in leafy vegetables than other types of vegetables. In this work the concentrations of chromium, cobalt and nickel support Wong's observation but for cadmium, iron and lead did not support it.

CONCLUSION

The vegetable plants under the study were generally good sources of nutrients required by the human for optimum growth and development. The results were generally within range of the maximum permissible limits for heavy metals set by WHO (2008). These heavy metals are very dangerous to the health as they will be transferred through the absorption by the plants which will consequently be consumed by humans and animals. These potential toxic metals should be monitored to avoid build up in the vegetables beyond W.H.O permissible limit as

it more useful and serve as excellent source of nutrients for the populace.

RECOMMENDATIONS

In other to reduce the risk associated with these heavy metals the following recommendations are offered:

There should be close monitoring of the level of heavy metals in the farm so as to ensure that the concentration does not exceed the permissible limits.

There is a need for remediation measures as well as enlightenment of the farmers and the general populace on the ways of reducing the level of cadmium pollution.

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