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ASSESSMENT OF HEAVY METAL POLLUTANTS IN SOME SELECTED FRUITS AND VEGETABLES AND ITS HEALTH IMPLICATION IN KARAGE COMMUNITY, YOBE STATE

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Abstract: *Increasing incidence of kidney disease in the communities surrounding in karage town, Jakusko LGA of yobe state, Nigeria; presents a cause of concern. The prevalence of kidney disease has been traced to possible contamination of soil due the large scale use of agrochemistry to improve agricultural production. This research aimed at determining the level of some heavy metals in the fruit and vegetables obtainable around karage community and to establish target and intervention program in tackling the menace. In this paper, sample of vegetables and fruits where collected from six different farmlands (Gada A, B and C and Tsamiya A, B and C) along Gada and Tsamiya River and then analyzed for chromium (Cd), lead (Pb), Arsenic (As), Zinc (Zn) and Chromium (Cr) concentrations, using Atomic Absorption spectrophotometry (AAS) technique. The research findings revealed an average concentration of Pb between (1.042±0.065–1.010±0.012µg/kg), Cr (0.260±0.062µg/kg) with Gada (A) having the highest concentration in Tomato. While the average concentration of Cr, Pb, Cd and Zn in Water Melon fruit are relatively low. Tsamiya A B and C respectively has the highest concentration of Zn (4.424µg/kg). These average values of the Pb, Cr. Ar, Zn and Cd concentration are higher than the world health organization (WHO) permissible limits in fruits and vegetables, hence a possible health risk and could be linked to chronic kidney disease that affect the community.*

Key words: *Contamination, Pollution, Toxicity, Absorption, Agriculture, Spectrophotometry, Kidney, Vegetables, Fruits, Metals.*

INTRODUCTION

Increasing incidence of kidney disease in the communities surrounding in Karage Jakusko Local Govt..Area of Yobe State, Nigeria present a cause of concern. The prevalence of kidney disease has been traced to possible contamination of soil due to the large scale use of agrochemicals to improve agricultural production. This research is expected to reveal some promising possibilities for establishing target and intervention program recommended to identify cause and effect links and sustainable information in tackling the problem.

Vegetables constitute an essential dietary component by contributing protein, vitamins, iron, calcium and other nutrients, which are usually in short supply (Thompson and Kelly, 2000). They also act as buffering agents for acidic substances produced during the digestion process. Vegetables contain both essential and toxic elements over a wide range of concentrations. Metal accumulation in vegetables may pose a direct threat to human health (Turkdogan *et al*., 2003; Damek-porawa and Sawickakapusta, 2003). Vegetables take up metals by absorbing them from contaminated soils, as well as from deposits on different parts of the vegetables exposed to the air from polluted environments (Zurera-cosano *et al*., 2008). It has been reported that nearly half of the mean ingestion of lead, cadmium and mercury through food is due to plant origin. Moreover, some population groups seem to be more exposed, especially vegetarians, since they absorb more frequently "tolerable daily doses" Zurera-cosano *et al*., 2008).

Fruits and leafy vegetables are widely used for culinary purposes. They are used to increase the quality of soups (leafy vegetables) and also for their dietary purposes (Sobukola *et al.*, 2010). Fresh fruits and vegetables are of great importance in the diet because of the presence of vitamins and mineral salts among others (Sobukola *et al*., 2010).

Heavy metals are found naturally in the earth, and become concentrated as a result of human activities such as industrial production, mining, agriculture and transportation (Abulud *et al.,* 2007, Adeleken, and Abegunde 2011). These metals have both positive and negative roles in human life (Abulud *et al.,* 2007, Adeleken and Abegunde, 2011 and Agbaire, and Oyibo,. 2009). For instance, heavy metals such as copper (Cu), chromium (Cr), cobalt (Co), manganese (Mn) and zinc (Zn) are essential micronutrients for higher animals and for plant growth (Ahuja, S. 2009). However, at higher concentrations they can lead to poisoning. On the other hand, Lead (Pb), cadmium (Cd), Arsenic (As) and nickel (Ni) are significant environmental pollutants (Akbar; *et al*., 2006).

Studies have revealed that fruits and leafy vegetables are vulnerable to heavy metal contamination from soil, wastewater and air pollution. Heavy metals such as Cd, Cu, Pb, Cr, Zn, Ni, As, Co and Hg cannot be degraded or destroyed and can be accumulated in living tissues through the food chain, causing various diseases and disorders (Al Yemen, N. and Hashem. 2006).

The toxicity of heavy metals has two main aspects: the fact that they have no known metabolic function, but when present in the body they disrupt normal cellular processes, leading to toxicity in a number of organs, also the potential, particular of the so-called heavy metals mercury and lead, to accumulate in biological tissues, a process known as bioaccumulation and are excreted at a slow rate, compared with its uptake. It is therefore necessary to control the levels of these toxic metals in foodstuffs in order to protect human health (Authority of Ireland –food safety 2009). The aim of this research work is to determine the levels of some heavy metals in the fruits and vegetables obtainable in Karage Community.

i. To determine the levels of Arsenic, Cadmium, Chromium, Lead and Zinc in Fruits and vegetables from Karage Community.
ii. To compare the levels of some heavy metals with that of threshold concentration given recommended by WHO and FAO
iii. To make a comparative survey to ascertain the levels of toxicity and relate to kidney failure.

1.3 Significance of the study

The determination of levels of Arsenic, Cadmium, Chromium, Lead and Zinc in fruits and vegetables from Karage Community were used to sensitize the general population of Karage Community on the importance of environmental conservation. The study will also inform the authorities in environment management on the level of heavy metal pollution in Karage Community hence providing a reference for future studies on the same.

2.1 STUDY LOCATIONS

Two (2) different study locations (Gada and Tsamiya farmlands) were chosen in the Northern Geopolitical Region of the Federal Republic of Nigeria, Karage Community of Jakusko Local Government Area of Yobe State.

2.2 Study area

Karage is a community in Yobe State, northeastern Nigeria, situated along the Yobe River, a few miles downstream from the confluence of the Hadejia and Jama'are Rivers. It lies at an average elevation of approximately 299 meters, with geographic coordinates of 12°50'13.2"N and 10°54'38.6"E. The region experiences its hottest months in March and April, with temperatures ranging from 38°C to 40°C, and annual rainfall between 500 mm and 1000 mm. Karage is one of the largest villages under the Bade Emirate Council and has served as the headquarters of Bade Local Government Area since 1976. The predominant language spoken is Bade, a member of the Chadic language family, widely spoken across eastern and southern Gashua. The town is located near the Nguru-Gashua wetlands, a vital ecological and economic system that supports agriculture and biodiversity in the region.

Fig. I: Map of Karage community

2.3 Materials and Method

2.3.1. Samples collection

Samples were collected in clean polyethylene containers according to their types and preserved in the refrigerator prior to processing for drying. The Samples were washed (cleaned) thrice with DDW to remove the dirt and dust particles from the fruit surfaces. Then, samples were cuts (chopped or peeled) with clean stainless steel knife into small pieces (~2-3 mm size), kernels and seeds were removed, well mixed and dried in an oven at ~100°C for 24 hours to remove moisture in order to prevent food decay and microbial activity (Alzahrani, *et al*., 2017). Two dried samples of each type were subsequently grounded into a fine powder and homogenized using a clean pestle and mortar. The grounded samples were properly labeled and stored in pre-nitric acid washed and dried polyethylene bags at ~ –20°C prior to any further laboratory analysis or until used for acid digestion.

2.4 Materials and Method

The equipment used in this study were all calibrated to check their status before and in the middle of the experiments. Apparatus such as volumetric flasks, measuring cylinder and digestion flasks were thoroughly washed with detergents and tap water and then rinsed with deionized water. All Glass wares were cleaned with 10% concentrated Nitric acid (HNO3) in order to clear out any heavy metal on their surfaces and then rinsed with distilled-deionised water. The digestion tubes were soaked with 1% (w/v) potassium dichromate in 98% (v/v) H2SO4 and the volumetric flasks in 10% (v/v) HNO3 for 24 hours followed by rinsing with deionized water and then dried in oven and kept in dust free place until analysis began. Prior to each use, the apparatus was soaked and rinsed in deionized water.

2.4.1 Sample Pre-Treatment/Digestion

The samples were allowed to dry using hot oven (Model 30GC lab oven) and then ground into fine powder by using a porcelain mortar and pestle. As much as 100mg of each sample was weighed in to thoroughly clean plastic container (microwave tube) and 6ml of 65% HNO_3 and 2 ml of hydrogen peroxide 3:1 was added and allowed and to stand for a while. The plastic container (microwave tube) was then covered and placed in to microwave digester (Master 40 serial No: 40G106M) and digested. The digestion was carried out at a temperature of (120) for 30 min and then ramped at 20 per min to 180 and hold for 10 mins. The digestion was followed by a cooling to room temperature in the microwave. Potential presence of heavy metal in chemical which used in digestion was determined. Blanks were used simultaneously in each batch of the analysis to authenticate the analytical quality. The digested samples were diluted with deionized water to a total volume of 25 ml.

2.4.2 Preparation of 1000 mg/Litre stock AAS standard solution for selected heavy metals (such as Pb, Cr and Cd and other metals).

The determination of a given metal concentration in the experimental solution was based on its respective calibration curve. In plotting the calibration curves for lead, cadmium, zinc and other metals, a stock solution of each metal ion of (1000 ppm) was prepared by dissolving; 1.5980 g of Pb $(NO_3)2$, 2.1032 g of Cd $(NO_3)2$ (and other metals so as to get exactly 1.0 g of the desired metal in 100 ml of solution) in deionized water and then diluting to 1 liter in a volumetric flask.

2.4.3 Determination of metal content by AAS

Calibration curves were prepared to determine the concentration of the metals in the sample solution. The instrument was calibrated using series of working standards. The working standard solutions of each metal were prepared from standard solutions of their respective metals and their absorbance's were taken using the AAS. Calibration curve for each metal ion to be analyzed was prepared by plotting the absorbance as a function of metal ion standard concentration.

Concentration of the metal ions present in the sample was determined by reading their absorbance using AAS (Buck scientific model 210GP) and comparing it on the respective standard calibration curve. Three replicate determinations were carried out on each sample. The metals were determined by absorption /concentration mode and the instrument readout was recorded for each solution manually. The same analytical procedure was employed for the determination of elements in digested blank solutions and for the spiked samples.

2.5 Data Analysis

Data was analyzed using Microsoft Office Excel. The data were expressed in term of descriptive statistics while the figures were presented with Mean values as (Mean±SD). The data were statistically analyzed using statistical software for Microsoft Excel. Summary results are presented as mean ± standard deviation. Statistical significance was computed using pair samples t-test with a significance level of $p< 0.05$.

Table 1.0: E**lements with their wavelength**

S/No.	ELEMENTS	WAVELENGTH (nm)	Slit (nm)
1	Lead	283.2	0.7
2	Zinc	213.9	0.7
3	Chromium	357.9	0.7
4	Cadmium	228.8	0.7
5	Arsenic	193.7	0.7

RESULTS AND DISCUSSION

Table 2.0: The mean concentration of Arsenic, Cadmium, Chromium, Lead and Zinc content (mg/kg) (Mean ±SD) in vegetable samples

SAMPLE ID	**Cr**	**As**	**Pb**	**Cd**	**Zn**
Tomato Gd A	0.260±0.062	ND	0.103±0.015	ND	1.426±0.008
Tomato Gd B	0.140±0.010	ND	0.195±0.005	ND	1.535±0.007
Tomato Gd C	0.140±0.000	ND	0.197±0.007	ND	1.535±0.007
Tomato Ts A	ND	ND	1.010±0.012	ND	4.031±0.039
Tomato Ts B	ND	ND	0.690±0.026	ND	4.424±0.007
Tomato Ts C	ND	ND	1.042±0.068	ND	4.424±0.007
Permissible limit FAO/WHO(2001)	0	0	0.33	0.1	100

Keys: ND=Not detected, **GD**= Gada, **TS**= Tsamiya **SD**=Standard deviation

Tomato is one of the world most cultivated vegetable with a worldwide production of 129,650,000 tons, grown in almost all parts of the world and make about 10% of total vegetables (Sulaiman et al., 2019b). The mean concentrations of chromium ranged from 0.00-0.260 mg/kg of the studied samples. Gd A tomato sample had the highest chromium concentrations of (0.260 mg/kg), while the lowest as concentrations of (0.140 mg/kg) were recorded in Gd B and Gd C, and below detectable limit in tomato samples from Ts A, Ts B and Ts C. The mean concentrations of arsenic and cadmium were found to be below detectable limit in all the studied samples. The mean concentrations of lead ranged from 0.103-1.042 mg/kg in all the studied samples. The highest concentrations of lead found to be 1.042 mg/kg in Ts C tomato sample, while the lowest lead concentration was found to be 0.103 mg/kg in Gd A tomato sample.

The mean zinc concentrations ranged from 1.426-4.424 mg/kg in all the studied samples. The lowest zinc concentration of 1.426 mg/kg was recorded in Gd A tomato samples, while the highest was recorded to be 4.424 mg/kg in Ts C sample. Zinc is a one of an essential metal that important to human and plants. Zinc is also important in the structure stabilization of a large amount of proteins (Chasapis *et al.,* 2012; Song *et al*., 2009; Song *et al.,* 2010). Deficiency of zinc can lead to several disorders; such as results in poor pregnancy outcomes (King, 2000; Uriu-adams and Keen, 2010) and development of chronic diseases, including cardiovascular disease (Messner *et al.,* 2010; Afridi *et al.,* 2011) and can also cause cancer (Kazi *et al.,* 2010). When exceeding the permissible limit is becoming toxic (Krishna *et al.,* 2014).

The general the trend for heavy metals content in tomato samples was decline in the following order: Zn > Pb > Cr. The concentration of Cr and Pb were above maximum permissible limit set for vegetables by FAO/WHO. The concentrations of Cr, Pb and Zn in this study were lower than the values reported by Osama *et al*. (2012) and Ndinwaet *et al*. (2018). However, the results of Pb and Zn obtained in this study were similar than results reported by Sulaiman et al. (2019b). Similar study by Samuel et al. (2018), reported Cr concentrations in line with chromium recorded in this study.

Table 3.0 The mean concentration of Arsenic, Cadmium, Chromium, Lead and Zinc content (mg/kg) (Mean ±SD) in Fruit samples

SAMPLE ID	**Cr**	**As**	**Pb**	**Cd**	**Zn**
W. Melon GdA	0.117±0.000	ND	0.014±0.003	0.059±0.002	1.374±0.007
W. Melon GdB	0.117±0.000	ND	0.028±0.000	0.044±0.001	1.343±0.007
W. Melon GdC	0.098±0.001	ND	0.014±0.000	0.059±0.002	1.312±0.007
W. Melon TsA	0.039±0.003	ND	ND	ND	0.273±0.008
W. Melon TsB	0.081±0.112	ND	ND	ND	0.272±0.007
W. Melon TsC	0.019±0.003	ND	ND	ND	0.290±0.012
Permissible limit FAO/WHO(2001)					

The mean concentrations of chromium were 0.117 mg/kg, 0.117 mg/kg, 0.098 mg/kg in Gd A, Gd B and Gd C, while the concentrations of chromium in Ts A, Ts B and Ts C were 0.039 mg/kg, 0.081 mg/kg and 0.019 mg/kg respectively. Gd B melon sample had the highest chromium concentration (0.098 mg/kg) and lowest concentrations were found Gd A and Gd B samples. The arsenic was found to be below detectable limit in all the studied samples.

The mean concentrations of lead were 0.014 mg/kg, 0.028 mg/kg, 0.014 mg/kg in Gd A, Gd B and Gd C, while the concentrations of lead in Ts A, Ts B and Ts C were below the detectable limit. The maximum concentrations of lead value were recorded Gd B, while the least lead concentrations were found to be below detectable limit. The concentrations of cadmium 0.059 mg/kg, 0.028 mg/kg, 0.044 mg/kg in Gd A, Gd B and Gd C, while the concentrations of cadmium in Ts A, Ts B and Ts C were below the detectable limit. Gd A and Gd C had the highest cadmium values (0.059 mg/kg), while the lowest value (0.044 mg/kg) was found in Gd B and below detectable limit in Ts A, Ts B and Ts C. The concentrations of zinc in Gd were much higher than levels in Ts. The mean zinc values were ranged from 1.312-1.374 mg/kg Gd melon samples, while Ts values were ranged from 0.273-0.290 mg/kg. The lowest zinc concentrations were found to be 0.290 mg/kg in Ts A melon sample, while the highest was found to be 1.374 mg/kg in Gd A.

Conclusion

This study was conducted to elucidate the status of environmental implication of heavy metals in vegetable and fruit in Karage community. The mean concentration of heavy metals in vegetable and fruits samples followed a sequence of Zn > Pb > Cr > Cd. The heavy metal concentration followed Zn > Cr > Cd > Pb in fruit samples. Arsenic (As) was the only metal below the detectable limit in all the samples studied. The substantial amount of these heavy metals recorded in the study suggest the need for monitoring in order ensure quality protection; public health awareness should be encouraged to the surrounding communities on the effect of their daily activities in relation to their health.

Recommendations

The following recommendations were made based on the findings of this research work:

- The people in community should be educated on health risk associated with human exposure to heavy metals to prevent further pollution.
- There is need to study the concentration of such heavy metals in Soil, water, sediments and any other source that directly or indirectly link to the source of food of the populace.

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