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Research Paper

Determination of heavy metals in some selected vegetables cultivated in Sabon Tasha Yola, Adamawa State

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Dietary exposure to heavy metals such as lead (Pb), cadmium (Cd), zinc (Zn), copper (Cu) etc has been identified as a risk to human health through the consumption of vegetables. This study investigated the concentration of heavy metals in three varities of vegetable samples cultivated in Sabon tasha Yola south of Adamawa state using atomic absorption spectroscopy (AAS). The study showed that the concentration of copper in *Hibiscus sabdariffa, Letuca sativa* and *Amaranthus caudatus* were 0.021±0.003 mg/kg, 0.008±0.002mg/kg and 0.010±0.002mg/kg respectively. The concentration of cadmium in *Hibiscus sabdariffa* and *Letuca sativa* were 0.006±0.001mg/kg, 0.005±0.004mg/kg respectively and cadmium was not detected in *Amaranthus caudatus*. The concentration of zinc in *Hibiscus sabdariffa*, *Letuca sativa and Amaranthus caudatus* were 0.039±0.004mg/kg, 0.184±0.002mg/kg and 0.067±0.002mg/kg respectively. The concentration of iron in *Hibiscus sabdariffa*, *Letuca sativa* and *Amaranthus caudatus* were 0.353±0.003 mg/kg, 0.265±0.001 mg/kg and 0.071±0.001 mg/kg respectively. The concentration of nickel in *Hibiscus sabdariffa* and *Letuca sativa* were 0.006±0.001 mg/kg and 0.004±0.001 mg/kg but was not detected in *Amaranthus caudatus.* The concentration of lead in *Hibiscus sabdariffa* was 0.018±0.004 mg/kg but was not detected in both *Letuca sativa and Amaranthus caudatus.* From this study, the concentrations of heavy metals in all the samples were within the recommended standard of WHO/FAO and are therefore relatively safe for human consumption.

Key words: *Hibiscus sabdariffa*, *letuca sativa, amaranthus caudatus* heavy metals and vegetables

INTRODUCTION

Vegetables are those herbaceous plants whose part or parts are eaten as supporting food or can serve as the main food. They may be aromatic, bitter or tasteless. In everyday usage, a vegetable is any part of a plant that is consumed by humans as food or as part of a savory meal. The term vegetable is somewhat arbitrary, and largely defined through culinary and cultural tradition. The original meaning of the word vegetable, still used in biology, was to describe all types of plant, as in the terms "vegetable kingdom" and "vegetable matter". Vegetables are all the other parts of the plant, including the leaves (e.g. lettuce and spinach), roots e.g. carrots and radishes, stems e.g. ginger and celery and even the flower buds e.g. broccoli and cauliflower.

Vegetables can be eaten either raw or cooked and play an important role in human nutrition, being mostly low in fat and carbohydrates, but high in vitamins, minerals and fiber. Many governments encourage their citizens to consume plenty of vegetables, five or more portions a day often being recommended. The consumption of vegetables as food offer rapid and least means of providing adequate vitamins, supply minerals and fibers. Vegetables that are used as food include those used in making soups or served as integral parts of the main sources of a meal. 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. Vegetables play important roles in human nutrition and health, particularly as sources of vitamin C, thiamine, niacin, pyridoxine, folic acid, minerals, and dietary fiber (Siegel et al., 2014)

Nigeria is endowed with a variety of additional vegetables and different types are consumed by the various ethnic groups for different purposes. Vegetables are eaten in a variety of ways as part of the main meal or as snacks. The nutrient content of leafy vegetables varies considerably, though generally they contain protein or fat and varies in the proportion of vitamin they contain such as vitamin A, vitamin K, and vitamin B, minerals and carbohydrate.

Leafy vegetables are not major sources of carbohydrate compared with starchy food. Scientific evidence has shown that frequent consumption of vegetables can prevent esophageal, stomach, pancreatic, bladder and cervical cancer and that a diet high in vegetables could prevent 20% of most types of cancer. Eating vegetables regularly in diet can have many health benefits by reducing many health related diseases and used to convert the fats and carbohydrates into energy. Fruits are generally low in energy density and often are good sources of fiber and potassium, but the nutritional contribution of standard servings of fruits and vegetables varies widely (Hornick et al., 2011). The utilization of locally available vegetables is limited due to lack of knowledge and information on their nutritive value (Sarkiyayi and Ikioda, 2010).Data on phytonutrients concentrated in fruits and vegetables are limited . It was estimated that the usual intake of 9 individual phytonutrients in Americans consuming the recommended levels of fruits and vegetables varies (Murphy et al., 2011)

According to reports, vegetables consumption is influenced by gender, age income education and family origin and as well as health status. Some vegetables are also reserves for the sick and convalescence because of their medicinal properties. In Nigeria, most rural dwellers rely on leaves gathered from the wild as their main source of leafy vegetables. These vegetables are harvested at all stages of growth and fed either as processed, semi-processed or fresh to man while they are usually offered fresh to live stock. Leafy vegetables are known to add taste and flavor, as well as substantial amount of protein fiber, minerals and vitamins to our diet. While the amount of nutrient constituent in the more commonly used leafy vegetables species in Nigeria have been studied to some extent, the lesser known region and local species remain virtually neglected. Lack of information on the specific nutrients and phytochemicals in a large number of the native vegetable species with which Nigeria is richly endowed is partly responsible for their under exploitation especially in areas beyond the traditional location where they are found and consumed.

Heavy metals deposition are associated with a wide range of sources such as small scale industries (including battery, Metal smelting and cable coating industries); vehicular emissions, and diesel generator sets. Heavy metals such as cadmium, lead and zinc are important environmental pollutant, particularly in areas where vegetables are irrigated with waste water, consumption of vegetables such as spinach, cabbage, lettuce, Bitter leaf and pumpkin by humans and animals pose serious health hazards. In some potential polluted areas, average levels of heavy metals, such as Cadmium or lead were more than 0.2 mg/kg in vegetables (Cao, 2014) are consumed. Although some heavy metals as Lead, Cadmium and Magnesium are important in plant nutrition, many of them do not play any significant role in the plant's physiology. The uptake of these heavy metals especially into the human food is done through these leafy vegetables and they have harmful effects on health. Heavy metals are non biodegradable and persistent environmental contaminants which are deposited on the surfaces and then absorbed into the tissues of vegetables. Plants take up heavy metals by absorbing them from contaminated soil (John et al., 2012).

Small amounts of heavy metals are needed in our environment and diet and are actually necessary for good health, but large amount of any of them may cause acute or chronic toxicity (poisoning).Heavy metal elements such as copper (Cu) and zinc (Zn) are important nutrients for humans, but excessive ingestion can also have adverse effects on human health. For example, a Copper surplus can cause acute stomach and intestine aches, and liver damage while zinc can reduce immune function and levels of high-density lipoproteins (Rahman et al., 2014). Heavy metal toxicity can result in damaged or reduced mental and central nervous function, lower energy levels and damage to blood composition, lungs, kidneys, liver, and other vital organs. Long term exposure may result in slowly progressing physical, muscular, and neurological degenerative processes, allergies are not uncommon, and repeated long-term contact with some metals (or their compounds) may cause cancer. For some heavy metals, toxic levels can be just above the background concentrations naturally found in nature. It is important to have knowledge of heavy metals so that we can take protective measures against excessive exposure. The association of symptoms indicative of acute toxicity is not difficult to recognize because they are usually severe, rapid in onset, and associated with a known ingestion or exposure. Small scale industrial activities are carried out in most of the areas where vegetables are cultivated. Most of the products of these activities are heavy metals which contaminate the environment. Heavy metals are non biodegradable and persistent environmental contaminants which are deposited in soil or washed into water and used for irrigation. It is in the light of this research was carried out to that determine heavy metals such as Iron, copper, Manganese, Nickel, Lead,Cadmium and zinc present in *Letuca Sativa, Amaranthus caudatus,* and *Hibiscus sabdariffa* cultivated in Sabon Tasha Yola, Adamawa State, Nigeria.

MATERIALS AND METHODS

Vegetable samples

*Hibiscus sabdariffa (*Roselle)
letuca sativa (lettuce)
Amaranthus caudatus (spinach)

Chemicals and reagent

All other reagents and solvents used were ofanalytical grade.

Equipment

Atomic absorption spectrophotometer version 3.94C and Furnace

Study area

Sabon Tasha is located in the southern part of yola in Adamawa state. It is a commercial area where a lot of activities such as metal smelting, cable coating, battery repairs, as well as automobile repairs are carried out in the area. It is also one of the major areas where vegetables consumed in yola are cultivated.

Collection of plant sample

Three samples each of *Letuca Sativa, Amaranthus caudatus,* and *Hibiscus sabdariffa* were randomly selected from a particular farm in Sabon Tasha. The samples were collected in the morning and it was from vegetables that were matured and ready to be cultivated. Precautionary measures were taken to avoid any form of contamination.

Sample preparation

Dry ashing

This method involves the complete combustion of all the organic matter only in the raw and processed sample to remain only the non-volatile inorganic mineral element. The combustion starts by burning the material on the non-luminous part of the Buns en flame until it stopped smoking and then transferred into a muffle furnace which is set to 500°C.

Procedure

The sample was properly washed to avoid contamination with soil particles. The samples were spread out to dry under shade and it was not exposed to direct sunlight. The sample was allowed to dry properly. After drying, the sample was crushed properly to tiny particles preferably to powdered form. 3 grams of the sample was weighed and placed in a muffle furnace. The sample was heated to volatilize as much organic matter as possible in a temperature control muffle furnace of about 500°C for six hours. The sample became dry and charred; and it turns to ash at that temperature and no carbon remains. After ashing was completed the dish was removed from muffle furnace, cool and covered with a watch glass. The sample was poured into a volumetric flask and 30 ml of Nitric acid was added to the sample and was properly stired. 10 ml of deionized water was added to the volumetric flask. It was Filtered into a 100 ml volumetric flasks using whatsman No.1 filter paper. Deionised water was added till the liquid is up to 100 ml and heated on steam bath for 15 min and ready for the analysis.

Determination of the selected heavy metals using atomic absorption spectrophotometer

The analysis of heavy metals such as zinc, cadmium, nickel, copper, iron etc present in the sample solution can be carried out by the use of instrumental method. However the instrumental method of analysis is very reliable and the instrument for these analyses is the Atomic absorption spectrophotometer (AAS). The calibration of the instrument using standards and blank was frequently done between samples to ensure stability of the base line. However as the concentration of the target atom in the sample increases, absorption was also increased proportionally. Thus, one runs a series of known concentration of some compound, and records the corresponding degree of absorbance which was an inverse percentage of light transmitted. The light beam was generated by lamp that was specific for a target metal. The light passed through the flame was received by the monochromator which was set to accept and transmit radiation at the specified wavelength and travels into the detector. The detector measures the intensity of the beam of light. When some of the light was absorbed by metal, the beams intensity reduced. The detector records that reduction as absorption. The absorption was shown on output device by the data system.

Statistical analysis

A one way analyses of variance was used to determine the variation in concentration of the three sample of vegetable at 0.05 level of significance.

RESULTS

Metals content of *hibiscus sabdariffa* (roselle) in Sabon Tasha

Table 1 shows the level of Cu, Cd, Zn, Fe, Ni, Pb in Roselle (*Hibiscus sabdariffa)* sample cultivated in Sabon Tasha Yola Adamawa State. The metal with the highest concentration was iron (0.353 mg/kg) while the metal with the lowest concentration include nickel and cadmium (0.006 mg/kg) in the sample.

Metals content of lettuce (*letuca sativa)* in Sabon Tasha

The metal content of lettuce in Sabon Tasha is shown in (Table 2). The metal with the highest concentration in lettuce (*letuca sativa)* sample is iron (0.265 mg/kg) while the metal with the lowest concentration is nickel (0.004 mg/kg) and Lead was not detected in the sample.

Metals content of spinach *(Amaranthus caudatus)* in Sabon Tasha

Table 3 shows the concentration of the metals in spinach *(Amaranthus caudatus)* indicating that iron also has the highest concentration (0.071 mg/kg) while the metal with the lowest concentration is copper (0.010 mg/kg) while cadmium, nickel and lead were not detected in the sample.

DISCUSSION

Although heavy metals such as iron are essential in human nutrition, their determination in food products is important, since at high concentrations they pose health risk. Most vegetables are consumed raw or lightly cooked in other to retain the nutrient content and it is more nutritious when it is cooked fresh compared to when it is dry. It is therefore recommended that vegetables should be cooked fresh so as to retain their nutrient content (Sarkiyayi and Ikioda 2010). In this study the concentration of Copper (Cu) in *Hibiscus sabdariffa* (Roselle), *letuca sativa* (Lettuce) and *Amaranthus caudatus* (Spinach) was 0.021 mg/kg, 0.008 mg/kg and 0.010 mg/kg respectively. When the concentration of Cu was compared with values reported in literature, the values were found higher than 3.03 – 6.24 µg/g reported by Fisseha, (2002) in vegetable crops. Thilini et al. (2014) also reported 7.05-18.44 mg/kg which was higher than those reported in this study. The result obtained in this study also revealed that the concentration of copper in the entire sample is lower than the WHO/FAO recommended value (2.00 mg/kg). More so, it should be noted that Cu is required as an essential dietary element. It is required for cellular metabolism in enzymatic and non-enzymatic system. Copper acts as important metallic-activators of several enzymes. Deficiency of Cu causes low white blood cell count and poor growth. Excess intake of Cu can cause vomiting, nervous system disorder and Wilson's diseases (Lewis et al., 1995).

In this study the concentration of Cadmium was 0.006 mg/kg and 0.005 mg/g in *Hibiscus sabdariffa* (Roselle) and *letuca sativa* (Lettuce) respectively but it is absent in *Amaranthus caudatus* (Spinach). From the study, it is clearly revealed that the concentration of cadmium is lower than the recommended WHO/FAO standard (0.025 mg/kg). It should be noted that Cadmium is one of the most toxic elements with reported carcinogenic effects in human. The concentration of Cd uptake in plants that may eventually be consumed by man raises serious health concern. Dike et al. (2004) reported that Cadmium is suspected to have carcinogenic and mutagenic effect in humans that are exposed to Cd contaminated foods or water. It accumulates mainly in the kidney and liver and high concentration has been found to lead to chronic kidney dysfunction. It induces cell injury and death by interfering with calcium regulation in biological systems. It has been found to be toxic to fish and other aquatic organisms. Cadmium has been implicated in endocrine disrupting activities, which could pose serious health problems.

In this study the concentration of zinc was 0.039 mg/kg, 0.184 mg/kg and 0.067 mg/kg in *Hibiscus sabdariffa* (Roselle), *letuca sativa* (Lettuce) and *Amaranthus caudatus* (Spinach) respectively. Zinc is one of the important metals for normal growth and development in human beings. Deficiency of Zn can result from inadequate dietary intake and results in impaired absorption, excessive excretion or inherited defects in Zn metabolism (Colak et al., 2005, Narin et al., 2005,. The levels of Zn in this study were lower than the 11.00 cmg/kg recommended limit (FAO/WHO).

In this study the concentration of iron was 0.353 mg/g, 0.265 mg/g, and 0.067 mg/g in *Hibiscus sabdariffa* (Roselle), *letuca sativa* (Lettuce) and *Amaranthus caudatus* (Spinach) respectively. In general, the concentrations of Fe in all the three samples were lower than 8.00mg/kg recommended limit by FAO/WHO in foods. Iron plays many key roles in biological systems including oxygen transport (haemoglobin and myoglobin), respiration and energy metabolism (cytochromes and iron-sulfur proteins), destruction of hydrogen peroxides (hydrogen peroxidase and catalase), and DNA synthesis (ribonucleotide reductase) (Melaku, 2009). Deficiency of Fe is one of leading risk factors for disability and death worldwide. It results in anemia which is recognized by its symptoms such as low blood Fe level, small red blood cells and low blood hemoglobin values.

In this study the concentration of Nickel was 0.006 mg/g and 0.004 mg/g in *Hibiscus sabdariffa* (Roselle) and

Table 1. Metals detected in Roselle *(Hibiscus sabdariffa).*

Metals	Conc. (mg/kg)	WHO/FAO Standard, RDA (mg/kg)
Copper	0.021±0.003	2.00
Cadmium	0.006±0.001	0.025
Zinc	0.039±0.004	11.00
Iron	0.353±0.003	8.00
Nickel	0.006±0.001	0.10
Lead	0.018±0.004	0.10

Values are mean ± standard deviation
ND = Not Detected
RDA = Recommended Dietary Allowance

Table 2. Metals detected in lettuce (*Letuca sativa).*

Metal	Conc. (mg/kg)	WHO/FAO Standard. RDA (mg/kg)
Copper	0.008±0.002	2.00
Cadmium	0.005±0.004	0.025
Zinc	0.184±0.002	11.00
Iron	0.265±0.001	8.00
Nickel	0.004±0.001	0.10
Lead	ND	0.10

Values are mean ± standard deviation
ND = Not Detected, RDA = Recommended Dietary Allowance

Table 3. Metals detected in spinach *(Amaranthus caudatus).*

Metal	Conc. (mg/kg)	WHO/FAO Standard, RDA (mg/kg)
Copper	0.010±0.002	2.00
Cadmium	ND	0.025
Zinc	0.067±0.002	11.00
Iron	0.071±0.001	8.00
Nickel	ND	0.10
Lead	ND	0.10

Values are mean ± standard deviation
ND = Not Detected
RDA = Recommended Dietary Allowance

letuca sativa (Lettuce) respectively but is absent in *Amaranthus caudatus* (Spinach). When the concentration of Nickel obtained in this study was compared with values reported in literature, samples in this study were found to lower than 0.71-15.89mg/kg which was reported by Thilini et al. (2014). In another literature the result of this present study was higher than 0.80 – 0.89µg/g and 2.73 – 6.90µg/g reported by Fisseha, (2002) and Awode et al. (2008), respectively.

In this study the concentration of Lead was 0.018mg/g in *Hibiscus sabdariffa* (Roselle) but is absent in both *letuca sativa* (Lettuce) and *Amaranthus caudatus* (Spinach). The result of this study also revealed that the concentration of lead is lower than the WHO/FAO standard (0.10 mg/kg). The levels of Pb reported in this study are higher when compared to that reported in the leaves of lettuce (0.01 mg/kg) by Adu et al. (2012). The Pb contents of the plants in this study are lower when compared to the FAO/WHO (2001) safe limit of 0.3 mg/kg. The study showed that, in the plant, Pb contents are within the permissible limit. Thus, the Pb level in the leafy parts of the vegetables examined seems not to be alarming except in a case of excessive consumption (Shuaibu et al., 2013). Consistent with its role as a non essential element, lead and its inorganic compounds have a relatively high order of acute toxicity (Beliles, 1994). However, the absorption is increased in individuals with iron deficiency. In humans, the degree of lead absorption from the gastrointestinal system is generally low, of the order of 3% (Beliles, 1994).

Conclusion

The present study has indicated that the different samples *Letuca Sativa* (lettuce)*, Amaranthus caudatus (*spinach) and *Hibiscus sabdariffa* (Roselle) that were analyzed are safe for human consumption since the concentration obtained for all the heavy metals were within the range when compared with the WHO/FAO recommendation guideline. Therefore the vegetables cultivated in this area are safe for human consumption.

Recommendation

Routine monitoring of heavy metal concentration in vegetables is highly recommendable. More research should be carried out in various areas where vegetables are cultivated. Government agencies should discourage industrial activities such as metal smelting, cable coating automobile repairs etc in areas where vegetables are cultivated.

REFERENCES

Adu AA, Aderinola OJ, Kusemiju V (2012). Heavy metals concentration in Garden lettuce (*Lactuca Sativa* L.) grown along Badagry expressway, Lagos, Transnat. J. Sci. Technol. 2(7):115-130.

Awode UA, Uzairu A, Balarabe ML, Harrison GFS Okunola OJ (2008). Assesment of Peppers and Soils for some Heavy metals from Irrigated Farmlands on the banks of River Challawa, Nigeria Pakistan Journal of Nutrition, 7(2): 244 – 248.

Beliles RP (1994). The metals. In: Patty's Industrial Hygiene and Toxicology, Fourth edition, Volume 2, Part C. Edited by Clayton, GD, Clayton FE, John Wiley & Sons, Inc, New York.

Cao SH (2014). Health risks from the exposure of children to As, Se, Pb and other heavy metals near the largest coking plant in China. Sci. Total Environ. 472:1001–1009.

Colak H, Soylak M, Turkoglu O (2005).Determination of trace metal content of various herbal and fruit teas produced and marketed from Turkey. *Trace Elements and Electrolyte*, **22:** 192 – 195.

Dike NI, Ezealor AU, Onyiye SJ (2004). Concentration of Pb, Cu, Fe and Cd during the dry season in River Jakara, Kano.Chemclass Journal 2004 (78-81).

Fisseha I (2002). Metal in leaf vegetables grown in Addis Ababa and toxicological implications. *Ethiopia Journal of Health Development,* 16(3): 295 – 302.

Hornick BA, Weiss L (2011). Comparative nutrient analysis of commonlyconsumed vegetables. Nutrition Today. 46:130–137.

John O, Jacob S, kakulu E (2012). Assessment of Heavy Metal Bioaccumulation in Spinach, Jute Mallow and Tomato in Farms within Kaduna Metropolis, Nigeria. American Journal of Chemistry 2(1):13-16.

Lewis M, Worobey J, Ramsay DS, McCormack MK (1995). Prenatal exposure to heavy metals: effects on childhood cognitive skills and health status. *Pediatrics*, 89: 1010 – 1015.

Melaku Z (2009). Determination of the levels of selected essential and toxic metals in canned tomato paste. A Thesis submitted to the Department of Chemistry, Addis Ababa University.

Murphy MM, Barraj LM, Herman D, Bi X, Cheatham R, Randolph RK (2011).Phytonutrient intake by adults in the United States in relation to fruit and vegetable consumption. J. Am. Diet Assoc. Epub 2011 Nov 9.

Narin I, Tuzen M, Sari H, Soylak M (2005).Heavy metal content of potato and corn chips from Turkey.*Bulletin of Environmental Contamination and Toxicology*, **74:** 1072 – 1077.

Rahman MA, Rahman MM, Reichman SM, Lim RP, Naidu R (2014). Heavy metals in Australian grown and imported rice and vegetables on sale in Australia: Health hazard. Ecotoxicol. Environ. Saf. 100:53–60.

Sarkiyayi S, Ikioda H (2010). Estimation of thiamin and ascorbic acid contents in fresh and dried Hibiscus sabdariffa (Roselle) and letuca sativa (lettuce). Advanced journal of food science and technology, 2(1).

Shuaibu K, Yahaya M, Abdullahi UK (2013). Heavy metal levels in selected green leafy vegetables obtained from Katsina central market, Katsina, Northwestern Nigeria 7(5):179-183.

Siegel KR, Ali MK, Srinivasiah A, Nugent RA, Narayan KMV (2014). Do we produce enough fruits and vegetables to meet global health need? PloS one9:e104059.

Thilini K, Jagath W, Anil G (2014). "Heavy metal contamination in green leafy vegetables collected from selected market sites of piliyandala area, Colombo district, sri lanka" American Journal of food science and technology 2.5 (2014): 139-144.