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Assessment of Trace Metals in Selected Green Leafy Vegetables

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***Abstract*:** *Vegetables are important and rich sources of vitamins, minerals, and fibres with medicinal uses. However, ingestion of vegetables containing trace metals is one of the routes through which these elements enter the body which may cause an array of diseases if not carefully monitored. This study was carried out to analyze the trace metals (heavy metals) likely present in some leafy vegetables, such as bitter leaf (Vernonia amygdalina), fluted pumpkin (Telfaria occidentalis) and Bologi leaf (Senecio biafrae). The vegetables were sampled from different communities in Obokun and Oriade Local Government Area of Osun State, Nigeria. The vegetables were digested using nitric acid (HNO_3) and perchloric acid ($HClO_4$) in the ratio 3:1 and Atomic Absorption Spectrophotometer (AAS) was used to analyze the trace metal content of the digested samples. The calculated mean concentrations of each trace metal in the sample indicated that the level of lead (Pb) ranged from 0.56-0.01 mg/kg, Iron (Fe) ranged from 3.50- 0.17 mg/kg, Chromium (Cr) ranged from 0.08-0.001 mg/kg and Manganesse (Mn) ranged from 0.79-0.01 mg/kg in the leafy vegetables respectively. These results were further compared with the permissible level set by WHO, FAO, and EU levels of trace metals were below the set standards. In conclusion, from this stand point of their trace metals content, the leafy vegetables were relatively safe for consumption without immediate risk of toxicity.*

Keywords: Trace metals, Vegetables, Toxicity, Obokun, Oriade, Spectrophotometer.

INTRODUCTION

Vegetables are parts of plants that are consumed by humans or other animals as food. Vegetables constitute an important part of the human diet since they are rich in carbohydrates, proteins as well as vitamins, minerals and trace elements. However, they may also contain both essential and toxic elements over a wide range of concentrations (Surukite *et al*., 2013). The original meaning of vegetables commonly used is collectively applied to all edible plant matters, including the flowers, fruits, stems, leaves, roots, and seeds. At first, plants which grew locally would have been cultivated, but as time went on, trade brought exotic crops from elsewhere to add to domestic types. Nowadays, most vegetables are grown all over the world as climate permits, and crops may be cultivated in protected environments in less suitable locations. 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 dietary fiber. Vegetables contain essential and toxic elements which are resent in wide range of concentrations as they are said to be good absorber of metals from the soil (Eslami *et al*, 2007; Shuaibu *et al*., (2013,). Vegetables are common diet taken by populations throughout the world, being sources of essential nutrients, antioxidants and metabolites (Thompson and Kelly, 1990). Vegetables absorb these metals from contaminated soils as well as from polluted environmental deposits through the roots and incorporate them into the edible part of plants tissues or deposit on the surface of vegetables (Haiyan and Stuanes, 2003, Nwajei, 2009).

Heavy metals are hazardous contaminants in food and the environment and they are non-biodegradable having long biological half-lives (Heidarieh *et al*, 2013). These metals can pose a significant health risk to plant and humans, particularly in elevated concentrations above the very low body requirements (Harmanjit and Dinesh, 2011).). These metals could reach food chain through various biochemical processes and ultimately biomagnified at various trophic levels and eventually threaten the health of human (WHO 1992). The contamination of soil and vegetables by heavy metals is also a global environmental issue. They are ubiquitous in the environment through various pathways, due to natural and anthropogenic activities (Wilson *et al*, 2007). Under certain environmental conditions metals may accumulate to toxic concentrations thereby causing ecological damages (Freedman, 1989). The heavy metals such as Cr, Mn, Ni, Zn, Cu, and Fe are considered essential components for biological activities in the body, but their presence in high concentrations is toxic and can cause a myriad of health problems to human body when consumed through along with vegetables. Heavy metals are one of a range of important types of contaminants that can be found on the surface and in tissue of dry vegetables. There are series of factors which influence the concentration of heavy metals on and within

plants. These factors include climate, atmospheric deposition, the nature of soil on which the plant is grown, application of fertilizers and irrigation with wastewater (Anyanwu *et al*, 2004)

Bitter leaf (Vernonia amygdalina) is a medicinal herb commonly known as bitter leaf. This plant is indigenous to tropical Africa and has enormous medicinal uses and is regarded as a gold mine by many African communities. The leaves of *Vernonia amygdalina* are used for consumption. They are washed before eating to reduce the bitter taste. The leaves are also used to stimulate the digestive system, reduce fever and as vegetables (Ojiako et al., 2006). Furthermore, they are used as local medicine against leech, which transmit bilharziasis. Traditional healers also believe that the leaves possess anti-parasitic and bacterial agents (Butter and bailey, 1993). Free living chimpanzees eat the leaves, if they have attacked by parasites.

Fluted pumpkin (*Telfairia occidentalis*), as a vegetable, is cultivated in various parts of southern Nigeria. It is widely cultivated for its palatable and nutritious leaves which are used mainly as vegetable. The seeds are also nutritious and rich in an oil which may be used for cooking and soap manufacture. It is rich in minerals (such as iron, potassium, sodium, phosphorus, calcium and magnesium), antioxidants and vitamins. The leaf extract is useful in the management of cholesterolemia, liver problems and impaired defense immune systems (Eseyin *et al*., 2005).

Bologi (*Senecio biafrae*), is a climbing herbal vegetable of secondary jungle that could be found along, roadsides in waste places and distributed on land of hilly country from Guinea to West Cameroons, and extending into central tropical Africa. It is consumed as a vegetable and constituent of a sauce and soups in Nigeria. Nutritionally, bologi also known as water leaf has been shown to possess the essential nutrients like Beta carotene, minerals (such as calcium, potassium and magnesium), pectin, protein and vitamins (Ezekwe et al., 2001). Bologi leaf has also been found to be used as herbal medicine in the management of cardiovascular diseases like stroke, obesity, etc. (Adewunmi and Sofowora, 1980). The aim of this study is to determine the level of concentration of trace metals in the leafy vegetables consumed in Obokun and Oriade Local Government Areas of Osun State

MATERIALS AND METHODS

Study sites and vegetable sampling

The green leafy vegetables which include Bitter leaf (*Vernonia amygdalina*), Fluted pumpkin (*Telfairia occidentalis*) and bologi (*Senecio biafrae*) samples were bought from Ibokun market and Esa-Oke market both in Obokun Local Government and Ijebu-Jesa market in Oriade Local Government, Osun state, Nigeria. Collected samples were separately packed in polythene bags and immediately transported to the laboratory for further treatment and analysis.

Sample pre-treatment

Samples collected (leafy vegetables) were rinsed with distilled water to remove debris from the surface. Thereafter, the samples were air dried. Each sample was weighed and further oven dried at 60^{O}C to constant weight. The dried samples were pulverized and passed through a sieve of 2 mm pore size. Finally, the samples were stored at room temperature in clean and dry polyethylene bottles with screw caps for further analysis at Chemistry Laboratory in Applied chemistry unit, Department of Science Laboratory Technology, Osun State College of Technology, Esa-Oke..

Sample digestion and heavy metals analysis

The method of Awofolu, (2005) was adopted in which 2.0 g of sieved leaf samples was weighed into 250 cm^3 Teflon beaker. Mixtures of concentrated nitric acid (HNO_3) and perchloric acid ($HClO_4$) in 3:1 was added to dissolve the sample. The beaker was heated at moderate temperature of 110°C on a hot plate for 1 h in a fume hood until transparent solution was formed. The digested sample solution was allowed to cool, filtered using Whatman No. 42 filter paper into 50 cm^3 standard volumetric flask and made up to the mark with distilled water. The samples were analyzed by Atomic Absorption Spectrophotometer (Model 2380, Perkin Elmer, Inc., Norwalk, CT, USA) for Fe, Cr, Pb and Mn. The instrument was calibrated using manually prepared standard solution of the respective heavy metals as well as drift blanks.

Data analysis

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

RESULTS

Table 1: The results were presented in mean and standard deviation statistical analysis (mg/kg).

Samples	Location	Pb	Fe	Cr	Mn
Bitter	Ijebu-Jesa	0.55 ±0.07	0.40 ±0.23	0.08 ±0.01	0.35 ±0.03
Leaf	Esa-Oke	0.56 ±0.21	3.50 ±2.05	0.06 ±0.01	0.50 ±0.26

	Ibokun	0.01 ±0.00	0.17 ±0.15	ND	0.01 ±0.00
Flute Pumpkin	Ijebu-Jesa	0.04 ±0.01	0.21 ±0.03	0.05 ±0.01	0.79 ±0.03
	Esa-Oke	0.56 ±0.18	3.34 ±3.34	0.07 ±0.01	0.22 ±0.01
	Ibokun	0.20 ±0.00	0.24 ±0.01	ND	0.02 ±0.00
Bologi Leaf	Ijebu-Jesa	0.07 ±0.01	0.77 ±0.23	0.04 ±0.00	0.48 ±0.06
	Esa-Oke	0.32 ±0.01	1.38 ±0.26	0.03 ±0.01	0.26 ±0.00
	Ibokun	0.01 ±0.00	0.25 ±0.01	0.001 ±0.00	0.02 ±0.00
WHO/FAO/EU Permissible values (mg/kg)*		2.00	48.00	1.30	5.00

ND = Not Detected

DISCUSSION

From Table 1 and Figure 1, it can be seen that Bitter leaf (*Vernonia amygdalina*) sample collected from Esa-Oke community showed high value of trace metals and ranges from 3.50 ±2.05 to 0.06 ±0.01 mg/kg followed by the sample collected from Ijebu-Jesa community which ranges from 0.55 ±0.07 to 0.08 ±0.01 mg/kg, while that of Ibokun community sample showed least value with range of 0.17 ±0.15 to 0.01 ±0.00 mg/kg. In Fluted pumpkin (*Telfairia occidentalis*) high value of heavy metals was also recorded from Esa-Oke sample which ranges from 3.34 ±3.34 to 0.07 ±0.01 mg/kg, Ijebu-Jesa sample recorded 0.79±0.03 to 0.04 ±0.01 mg/kg, while that of Ibokun sample ranges from 0.24 ±0.01 to 0.02 ±0.00 mg/kg. However, the value obtained from Bologi leaf (*Senecio biafrae*) compared with both Bitter leaf and Fluted pumpkin collected from Ijebu-Jesa community showed high value of trace metals which ranges from 0.77 ±0.23 to 0.04 ±0.00 mg/kg, followed by sample collected from Esa-Oke with low value of 1.38 ±0.26 to 0.03 ±0.01 and mg/kg, and finally sample from Ibokun with least value of 0.25 ±0.01 to 0.01 ±0.00 mg/kg.

The comparison of data obtained among the three location shows that the level of lead (Pb) ranged from 0.56 ±0.21 to 0.01 ±0.00 mg/kg, Iron (Fe) with 3.50 ±2.05 to 0.17 ±0.15 mg/kg, chromium (Cr) ranged from 0.08 ±0.01 to 0.001 ±0.00 mg/kg and Manganesse (Mn) ranged from 0.79 ±0.03 to 0.01 ±0.00 mg/kg respectively. Iron (Fe) was recorded with highest concentration among other trace metals present in the leafy vegetables. Among the various trace metals analysed in the green leafy vegetables a similar tread in metal content was observed, i.e Fe> Pb > Mn > Cr.

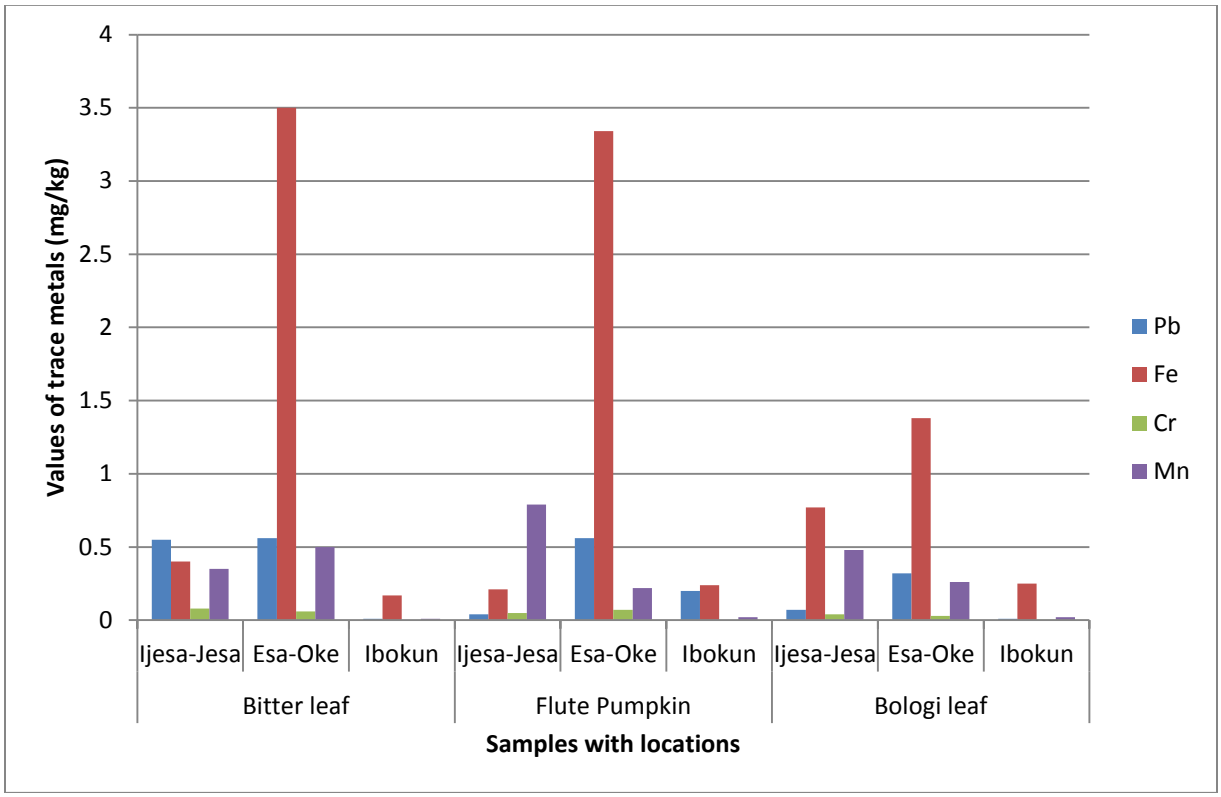

Figure 1: Graph of trace metals (mg/kg) randomly collected samples within the communities.

However, iron (Fe) Fe is essential for the synthesis of chlorophyll and activates a number of respiratory enzymes in plants. The deficiency of Fe results in severe chlorosis of leaves in plants. High levels of exposure to iron dust may cause respiratory diseases such as chronic bronchitis and ventilation difficulties. Fe content was recorded with highest value in bitter leaf, Fluted pumpkin and Bologi leaf compared with others trace metals such as Pb, Mn and Cr. The Fe mean values present in each of these three selected leafy vegetables are far below the mean value (12.873 mg/kg) recorded for lettuce (Adu *et al*., 2012).

Lead (Pb) is a toxic element that can be harmful to plants, although plants usually show ability to accumulate large amounts of lead without visible changes in their appearance or yield. Meanwhile, Pb was found to be highest in both bitter leaf and flute pumpkin samples used (Table 1 and Figure 1). In many plants, Pb accumulation can exceed several hundred times the threshold of maximum level permissible for human consumption (Muhammad *et al*., 2008). The high levels of Pb in some plants may probably be attributed to pollutants in irrigation water or farm soil (Qui *et al*., 2000).

In other hands, Chromium (Cr) is an important mineral mostly in carbohydrate production and metabolism, and also helps keeping the blood sugar level in balance by enhancing insulin–functions and hypoglycemia, i.e the preventing of level of glucose in the blood. In this study, Cr content recorded highest value in bitter leaf (0.07 mg/kg) followed by fluted pumpkin (0.04 mg/kg).

Finally, manganese (Mn) was found to have highest value in fluted pumpkin (0.79 mg/kg). It aid glucose metabolism by acting as a cofactor in the process of converting glucose food to energy. It is also important in digestion of food especially protein and in the production of cholesterol and fatty acid in the body. Mn also functions in bone growth and development and production of thyroid hormone etc. In comparison with FAO/WHO (1996) standard, it's deduced that the values of Mn recorded in the three leafy vegetables are under control.

Conclusion

In conclusion, the study showed that the trace metals found in the three leafy vegetables were at safe limit and this indicates that the leafy vegetables in Esa-Oke, Ibokun and Ijebu-Jesa communities were relatively safe for consumption without risk of environmental toxicity.

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