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Levels of Some Trace Metals in Two Leafy Vegetables Grown in Mbiaya Uruan, Akwa Ibom State, Nigeria

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ABSTRACT
Levels of Zn, Ni, Co, Mn and Fe in *Talinum triangulare* (water-leaf) and *Telferia occidentalis* (fluted pumpkin) highly consumed in Akwa Ibom State, were determined by standard methods. Samples were collected from different farms in Mbiaya Uruan, where the vegetables were cultivated without the application of fertilizers, pesticides and herbicides as well as non-irrigation with waste water, the metal levels (mg/kg) in water-leaf ranged from 0.01±0.02 Mn to 0.20±0.01 Ni in the order: Ni > Co > Zn > Fe > Mn. In fluted pumpkin, the metal levels (mg/kg) ranged from 0.01±0.01 Ni to 0.12±0.01 Co in the order: Co > Mn and Zn > Fe > Ni. The trace metal levels in the vegetable samples were far below the toxic doses of such metals in vegetables as prescribed by WHO/FAO. This could be attributed to good farming practices adopted by farmers in the area. Correlation between the trace metals in the vegetable samples gives a low positive correlation of $r = 0.24$ at $p = 0.05$, indicating that the metals were influenced by different natural factors. Consumption of the vegetables from the area, may not pose health hazard to consumers at the time of the study.
Keywords: Vegetables, trace metals, Mbiaya Uruan, farming practices, consumption, health hazard.

INTRODUCTION

Vegetables are edible portions (the leafy outgrowth) of plants used in soups or serving as integral parts of the main sources of our meals (Uwah *et al*., 2009; Okunade & Adesina, 2014; Uwah & Mkpa, 2016; Uwah *et al*., 2017). Vegetables are used as stable part of foods both in cooked and raw forms. It is believed that the required amount of vegetables in our daily diet must be 300 to 350 g per person (Uwah *et al*., 2017). Vegetables are considered as protective supplementary food and they constitute an important part of the human diets since they contain carbohydrates, proteins, as well as vitamins, minerals and trace elements (Uwah *et al*., 2017). Consumption of vegetables as food gives rapid means of providing adequate supplies of vitamins, minerals and fibres to the people (Uwah *et al*., 2009).

Leafy vegetables occupy a very important place in human diet, but unfortunately, constitute a group of foods which contribute maximally to trace metals consumption in humans (Uwah *et al*., 2017). The excessive applications of nitrogenous and other inorganic fertilizers and organic manures in soils where these vegetables are grown for the purpose of increasing productivity and yields contribute to high levels of trace metals in the crops (Anhahu, 2009). In recent years their consumption increases gradually, particularly among the urban community. This is due to increased awareness on the food value of vegetables, as a result of exposure to other cultures and acquiring proper education. However, these vegetables contain both essential and toxic elements over a wide range of concentrations particularly due to human activities (Uwah *et al*., 2017).

Trace metals are metals that are present at much lower concentration in water compared to major ions such as SO_4^{2-}, Cl^-, NO_3^-, Mg^{2+} and Ca^{2+} (Radojevic & Bashkin, 1999; Uwah *et al*., 2011). They are indeed metals with density or specific gravity greater than $5 g/cm^3$ and are also known as heavy metals. They are vital for good health if they come from plant or an organic source. However, they become toxic if they come from another source (Khan *et al*., 2008; Radwan & Salama, 2006). As such they are sometimes referred to as toxic metals. More than 50 elements have been classified as trace metals, about 17 of which are very toxic and relatively accessible (USEPA, 2006). Environmental effects from the contaminations of these metals can include the atmospheric contamination, drinking water, groundwater, soil, and the propagation of concentrated amounts of metals throughout the food chain (USEPA, 2006). Trace metals such as Cu, Zn, Mn, Fe, Ni, Co are essential in plant nutrition. Some of them do not play any significant role in the physiological aspect of the plants. Trace metals are persistent in the environment, they are non-thermo degradable and they readily accumulate to toxic levels (Sharma *et al*., 2007). Many soils, especially those in hazardous waste sites are contaminated by trace metals such as Ni, Cu, Zn, Cr. Trace metal contaminations of soils through industrial and anthropogenic activities are serious problems world over including Nigeria. The uptakes of these metals by plants, especially, the leafy vegetables are avenues of their entry into the human food chain with harmful effect on health (Sobukola *et al*., 2010).

Trace metals present in large amount in vegetables could have adverse effects to the plants and most especially human beings that feed on these plants. Therefore, pollution of soil by these substances is of concern because they can have direct and indirect phytotoxic impacts on the plants growing in such soil, leading to poor yield and thereby reducing our food supply. The knowledge of the levels of these trace metals in food stuffs can provide important information on the impact of using chemical products such as fertilizers, pesticides, herbicides and weedicides in farms and the extent of environmental pollution in such farms. There is therefore every need to study the levels of some trace metals in the two highly consumed leafy vegetables grown in Mbiaya Uruan, Uruan Local Government Area of Akwa Ibom State where the vegetables are cultivated without the application of chemical products such as fertilizers, pesticides, herbicides, weedicides and indeed without irrigation with waste water, thereby ascertaining the suitability of the vegetables for human consumption.

MATERIALS AND METHODS

Samples and Sampling: Fresh leaves of *Talinum triangulare* (water-leaf) and *Telferia occidentalis* (fluted pumpkin) were sampled in farms in Mbiaya Uruan in Uruan local Government Area of Akwa Ibom State where these vegetables are heavily cultivated without the application of fertilizers, pesticides and herbicides as well as irrigation with all kinds of water for both domestic and commercial purposes. Samples were collected in May, 2016. The collections were done randomly from different farms and homogenized into composite samples. Samples collections were carried out according to the methods described by Radojevic & Bashkin, (1999). The composite samples were taken in pre-cleaned polyethylene bags and transported to the laboratory for subsequent processes and analyses.

Digestion of Samples: Chopped portions of each vegetable samples were dried in an oven at 105^oC for 24 hours until they were brittle and crisp. About 1g of the dried, disaggregated and sieved vegetable samples were placed separately in 50 cm^3 Teflon beakers and then digested with 10 cm^3 of aqua regia (a combination of hydrochloric and sulphuric acids in the ratio of 3:1) to near dryness at 80 – 90^oC on a hot plate. The digests were filtered into 50 cm^3 volumetric flasks using Whatman No. 42 filter paper (Radojevic & Bashkin, 1999).

Determination of Trace Metals in the Samples: Levels of Zn, Ni, Co, Mn and Fe in the two vegetable samples were analysed using Perkin Elmer 300 Atomic Absorption Spectrophotometer (AAS) equipped with an air – acetylene burner. Standard solutions of each of the metals were prepared from their stock solutions and diluted with distilled water to the mark in 100cm^3 standard volumetric flasks. The trace metals levels were determined directly in each final digests (sample solutions) using the Perkin Elmer 300 AAS.

Data analyses: Descriptive statistics were performed using Excel 2007 spread sheet while Pearson correlations were tested using the SPSS statistical software package as adopted by Pentecost (1999) to determine the association between trace metals in the vegetable samples at $p = 0.05$.

RESULTS AND DISCUSSION

Levels of Trace Metals in the Vegetable Samples: Levels of Zn, Ni, Co, Mn and Fe analysed in the water-leaf samples are presented in Figure 1 while those of fluted pumpkin are presented in Figure 2. As presented in Figure 1, the metal levels (mg/kg) in water-leaf ranged from 0.01±0.02 Mn to 0.20±0.01 Ni in the order: Ni > Co > Zn > Fe > Mn. In Figure 2, the metal levels (mg/kg) in fluted pumpkin ranged from 0.01±0.01 Ni to 0.12±0.01 Co in the order: Co > Mn and Zn > Fe > Ni.

From Figures 1 and 2, the levels of the analysed trace metals in this study were below the toxic doses of the respective metals in vegetables as prescribed by World Health Organization (WHO). Levels of Mn obtained in this study were 0.01mg/kg in water-leaf and 0.05mg/kg in fluted pumpkin. These values were far below the toxic doses of 30 mg/kg Mn in vegetables as prescribed by WHO/FAO (1995). The 0.08 and 0.05 mg/kg levels of Zn in water-leaf and in fluted pumpkin, respectively, obtained in this study were far below the toxic doses of Zn given in the range of 60 - 400 mg/kg Zn in vegetables as prescribed by WHO/FAO (1995). Similarly, the levels of Fe (0.03 mg/kg) recorded in both water-leaf and fluted pumpkin were far below the toxic doses of Fe given in the range of 10 - 200 mg/kg in vegetables by WHO/FAO (1995). Accordingly, Co levels of 0.16mg/kg in water-leaf and 0.12 mg/kg in fluted pumpkin were below the toxic doses of Co which ranged from 0.05 - 0.50 mg/kg as prescribed by ATSDR (1999) while the levels of Ni (0.2 mg/kg in water-leaf and 0.01 mg/kg in fluted pumpkin) were

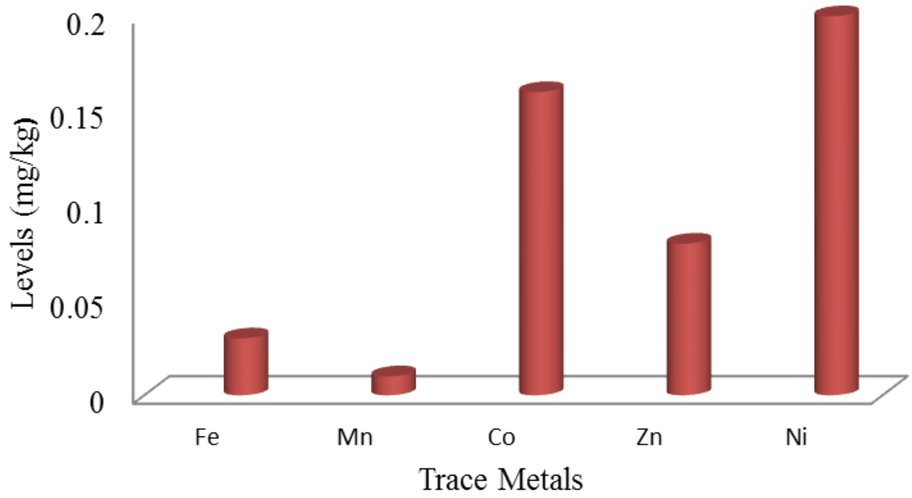

Figure 1: Levels (mg/kg) of some Trace Metals in *Talinum triangulare* (Water-leaf) Samples Obtained From Mbiaya Uruan

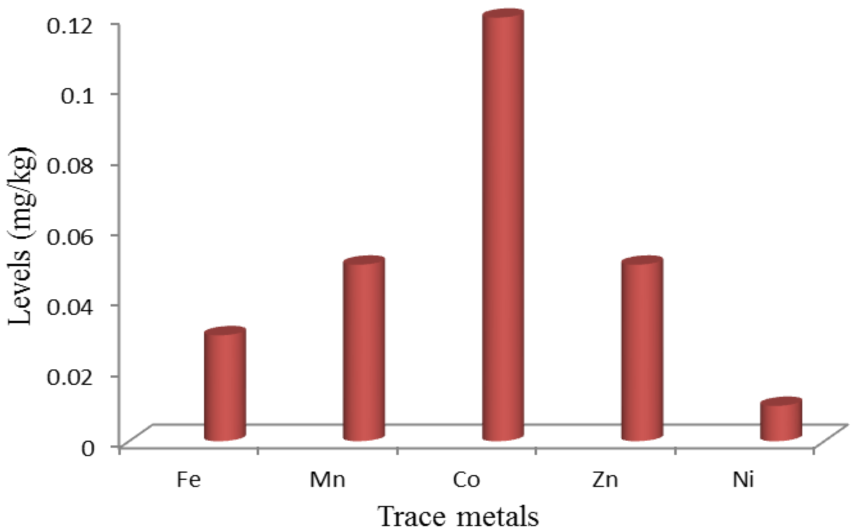

Figure 2: Levels (mg/kg) of some trace metal in *Telferia occidentalis* (Fluted pumpkin) Sample Obtained from Mbiaya Uruan.

far below the toxic doses of Ni in plants given in the range of 10 – 200 mg/kg by WHO/FAO (1995). The trace metals levels in vegetable samples analysed in this study were lower than those reported in similar studies in vegetables grown in soils where manure, organic and inorganic fertilizers, pesticides, herbicides and other chemicals were used to boost productivity and where waste waters were used to irrigate the farmlands. They were also lower than those reported in vegetables grown in areas contaminated with oil exploration activities. For example, those reported by Uwah (2009); Uwah *et al* (2011); Obi-Iyeke (2014); Kananke *et al* (2014); Wamalwa *et al* (2015); Uwah *et al* (2017). The levels of Fe and Ni in the fruited pumpkin samples analysed in this study were in agreement with those reported by Uwah *et al* (2017) in the control samples collected from Nkek in Ukanafun, where there are no oil exploration activities.

Adverse effects associated with the consumption of trace metals polluted foods are enormous. Among others, Salhotra & Verma (2017) had noted that the consumption of trace metals polluted foods can deplete some essential nutrients in the body thereby giving rise to a decrease in the immunological defenses, growth retardation, disabilities associated with malnutrition and high prevalence of upper gastrointestinal cancer rates. Hence, the needs to grow crops with serve levels of trace metals.

Relationship between the Trace Metals in the Vegetable Samples: The relationship between the trace metals in the vegetable samples is presented in Figure 3. The low positive correlation coefficient (r = 0.24) indicated that the trace metals in the vegetables were not influenced by similar anthropogenic activities but rather by different sources which could be natural.

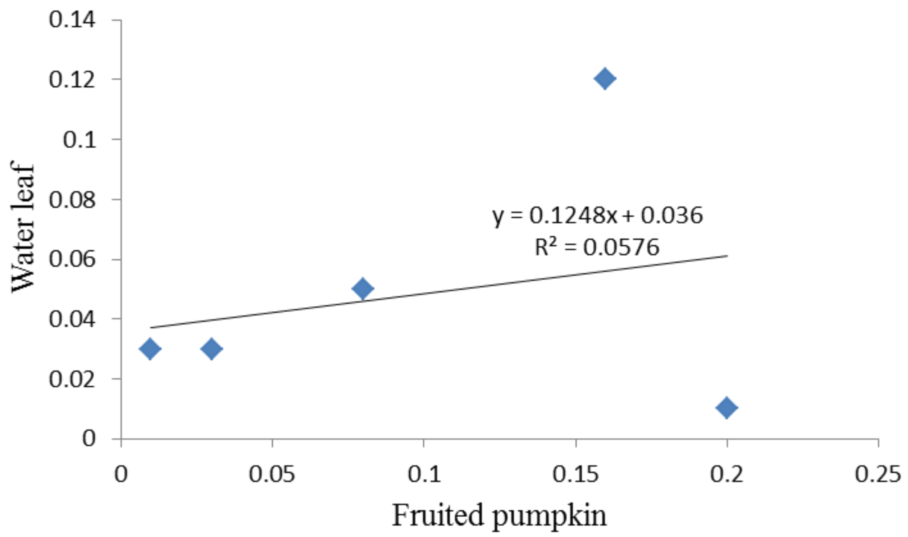

Figure 3: Correlation between the Trace Metals in the two Vegetable samples, r = 0.24

CONCLUSIONS

Based on the analyses and results, it could be concluded that the two highly consumed leafy vegetables *Talinum triangulare* (water-leaf) and *Telferia occidentalis* (fluted pumpkin)] grown in Mbiaya Uruan, Uruan Local Government Area of Akwa Ibom State,

i. Contain variable levels of Zn, Ni, Co, Mn and Fe.
ii. The levels of these trace metals in the vegetables were far below their respective toxic doses in plants as prescribed by WHO/FAO.
iii. The levels of these trace metals in the vegetables were lower than those reported in similar studies in vegetables grown in soils where manure, organic and inorganic fertilizers, pesticides, herbicides and other chemicals were used to boost productivity.
iv. The levels of these trace metals in the vegetables were lower than those reported in similar studies in vegetables obtained from areas where waste waters were used to irrigate the farmlands.

v. The trace metal levels in the vegetables were equally lower than those reported in vegetables grown in areas contaminated with oil exploration activities.
vi. The low levels of Zn, Ni, Co, Mn and Fe recorded in the vegetable samples investigated in this study could be attributed to good farming practices (such as non-application of organic and inorganic fertilizers, pesticides and herbicides) adopted by farmers in the area.
vii. Correlation between the trace metals in the vegetables gives a low positive correlation coefficient ($r = 0.24$) at $p = 0.05$, indicating that the metals were influenced by different natural factors rather than by similar anthropogenic activities.
viii. It could therefore be said that consumption of the vegetables grown in the study area would not pose possible health hazard to the consumers with regards to the levels of the analysed trace metals at the time of this study.

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