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ANALYSIS OF SOME HEAVY METAL CONTENTS IN SELECTED VEGETABLES FROM STATES IN NIGERIA

***UWADIAE, S.E., IRIABIJE, T.O. AND ALUYOR, E.O.**
Department of Chemical Engineering, University of Benin, PMB 1154, Ugbowo, Benin city, Nigeria
*Corresponding author: sylvester.uwadiae@uniben.edu

Abstract
This study was carried out in order to determine the concentrations of some heavy metals namely; lead, cadmium, nickel and zinc in selected vegetables. Cucumber (Cucumis sativus), watermelon (Cucurbita lanatus), tomato (Solanum lycopersicum) and pepper (Capsicum annuum), brought from Kano state as well as those cultivated in Edo state, Nigeria. A total of 25 samples consisting of four different vegetables were each purchased from two major markets where vegetables from Kano state are sold in Benin City as well as those cultivated in Benin City, Edo state, Nigeria. Edible portions of the samples were used for analysis. Samples for analysis were dried using the oven dry method at 105 ^{o}C for 24 hours and later ground. About 1.0g of the samples were each weighed and digested in a mixture of 10 ml Nitric–Perchloric acid in a 250 ml Kjeidahl flask under a fume hood. The content was mixed and heated gently at 120 – 200 °C for about 45 minutes on a hot plate. Heavy metals were present in all the vegetables analysed at various levels. Cadmium concentration ranges between 0.02 – 0.47 mg/kg, Lead was within the range of 0.03 – 11.12 mg/kg, zinc concentration ranges between 0.15 – 73.69 mg/kg, and nickel concentration ranges between 0.07 – 35.54 mg/kg respectively in all the vegetables from the two states. Cadmium and Lead were observed to be higher than that of the maximum permissible limit (MPL) stipulated by the World Health Organisation (WHO).

Key Words: *Vegetables, Toxicity, Heavy metals, Assessment*

Introduction

Irrigation using wastewater is known to contribute essentially to the overwhelming heavy metal levels of soils. If the plants die and decay, heavy metals taken into the plants are redistributed, so the pollutants in the soil are enhanced. Sewage water and industrial wastes are of great concern. These wastes are regularly depleted to horticultural terrains where it is utilised for increasing plant yield including vegetables. Effluents from sewage are not just thought to be rich wellspring of natural matter and different supplements, they are considered to elevate the concentration of heavy metals like Fe, Mn, Cu, Zn, Pb, Cr, Ni, Cd and Co in

receiving soils. The assimilation of these heavy metals by vegetables from the soil, polluted air and water leads to pollution of the food chain (Mohammed and Abdullahi, 2010).

It has been reported that in Kano state, Nigeria, a lot of industrial wastes, residential and abattoir wastewater are released into city streams and used for irrigation (Abdu, 2010). Most of the vegetable cultivated are used in the preparation of several delicacies in the northern part of Nigeria. These vegetables are usually irrigated with grey waste water from urban drainages contaminated through processes such as defecations, urination, bath, washing, agro – chemicals and industrial effluents (Chiroma *et al*., 2014). Similarly, these vegetables are brought to the southern parts of Nigeria, like Benin City in Edo state.

Wastewater from grey waste water from urban drainages contaminated through processes such as defecations, urination, bath, washing, agro – chemicals and industrial effluents have been found to contain several pollutants which include heavy metals. Heavy metals in most cases are accumulated in crops, and could adversely affect consumers feeding on these crops (Muamar *et al*., 2014). Heavy metals depositions are associated with a wide range of sources such as small scale industries (including battery production, metal products, metal smelting and cable coating industries); brick kilns; vehicular emissions; re-suspended road dust and diesel generator sets. These can be important contributors to the contamination found in vegetables (Surukite *et al*., 2013).

The consumption of fresh fruits and vegetables is increasing as humans (consumers) strive daily to eat healthy diets and benefit from the nutrients and year round availability. Most fruits and vegetables such as cucumber *(Cucumis sativus)*, watermelon *(Cucurbita lanatus)*, tomato *(Solanum lycopersicum*) and pepper *(Capsicum annuum)* are eaten without further processing. In spite of the health benefits of eating fruits and vegetables, there is an increasing concern about the potential contamination of fruits and vegetables from the application of pesticides, chemical fertilizers, herbicides and those cultivated through irrigation from contaminated wastewater. Contamination of vegetables with heavy metal is usually due to irrigation with contaminated water, the addition of fertilizers and metal-based pesticides, industrial emissions, transportation, the harvesting process, storage or at the point of sale (Nazemi, 2012). Ibrahim, *et al*. (2010) suggested that transportation and marketing systems of vegetables play a significant role in elevating the contaminant levels of heavy metals, which may pose a threat to the quality of the vegetables.

This study is aimed at determining the levels of selected heavy metals in some selected vegetables cultivated in Edo state and those brought from Kano state, and comparing these levels with the maximum permissible limit (MPL) stipulated by the FAO/WHO (2001).

Materials and Method

Sample Collection

Four types of vegetables namely; cucumber (*Cucumis sativus*), watermelon (*Cucurbita lanatus*), tomato (*Solanum lycopersicum*) and pepper (*Capsicum annuum*) were used in this study.

Vegetables from Kano state and those cultivated in Edo state were separately

purchased for the purpose of comparing the heavy metals levels in these vegetables from both states.

These vegetables were thoroughly washed first with tap water followed with double distilled water to remove any possible foliar contaminants such as pesticides, fertilisers, dust or mud after the bruised and rotten parts were removed. The samples were then labelled separately, kept in clean polyethylene bags and taken to the laboratory for analysis.

Sample Preparation and Treatment

The washed vegetable samples were peeled, sliced to obtain the edible portion for analysis and to increase the surface area for drying. Samples for analysis were dried using the oven dry method at 105^{o}C until the mass remained constant. The dried samples were ground manually using a porcelain mortar and pestle. 1 g each of ground samples were weighed using Ohaus weighing balance (JBIT, 5374 – 1991) and later placed in a 250 ml Kjeidahl flask for digestion.

Nitric – Perchloric Acid Digestion

Nitric–Perchloric acid digestion was performed, following the procedure given by the AOAC (1995). A mixture of nitric acid and perchloric acid was first prepared in ratio 10:1. 10mls of the prepared mixture was taken and added to 1g of the ground sample in a 250 ml Kjeidahl flask. The content was mixed and heated gently at 120 - 200°C for about 45 mins on a hot plate. The content was continuously heated until the brown fumes disappeared and dense white fumes appeared leaving a clear solution. It was then finally heated strongly for about 20 mins and then allowed to cool.

The cooled sample was filtered with Whatmann filter paper (No. 42) and transferred into a 100 ml volumetric flask and made up to the mark with distilled water. The 100 ml filtrate was transferred into a polyethylene bottle and covered to avoid spillage. The residual heavy metal concentrations of the digested vegetable samples were determined using with Atomic Absorption Spectrophotometer (Perkin-Elmer, 3000). The digestion was done in duplicate to track experimental error and show capability of reproducing result (Marshall and Champagne, 1995). This procedure was carried out for all the vegetable samples.

Results and Discussion

The mean concentrations of selected heavy metals present in samples obtained from Edo and Kano states and the FAO/WHO (2001) maximum permissible limits of the heavy metals in the vegetables are shown in Figure 1 to Figure 4.

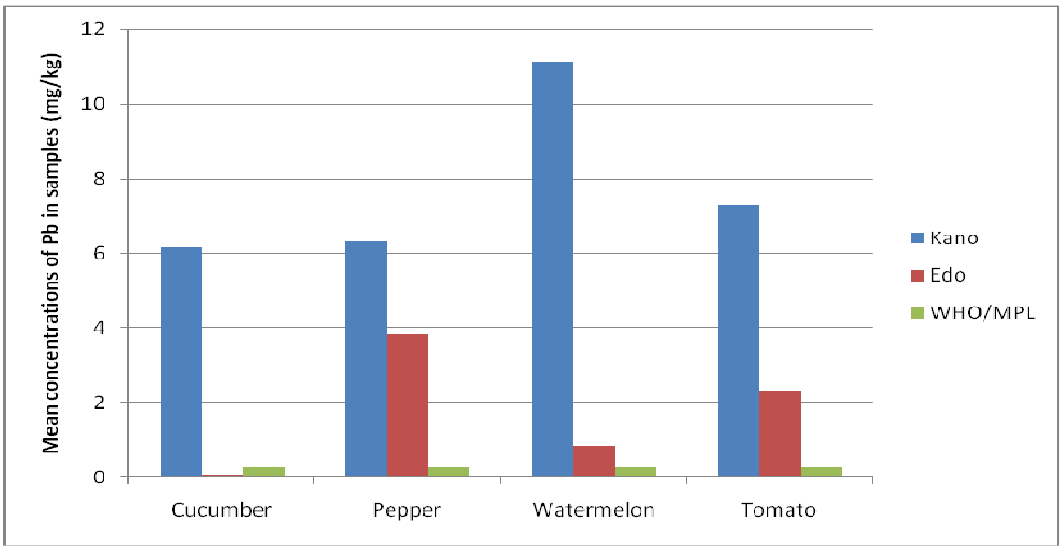

Fig. 1: Mean concentrations of Pb in samples from Kano and Edo states

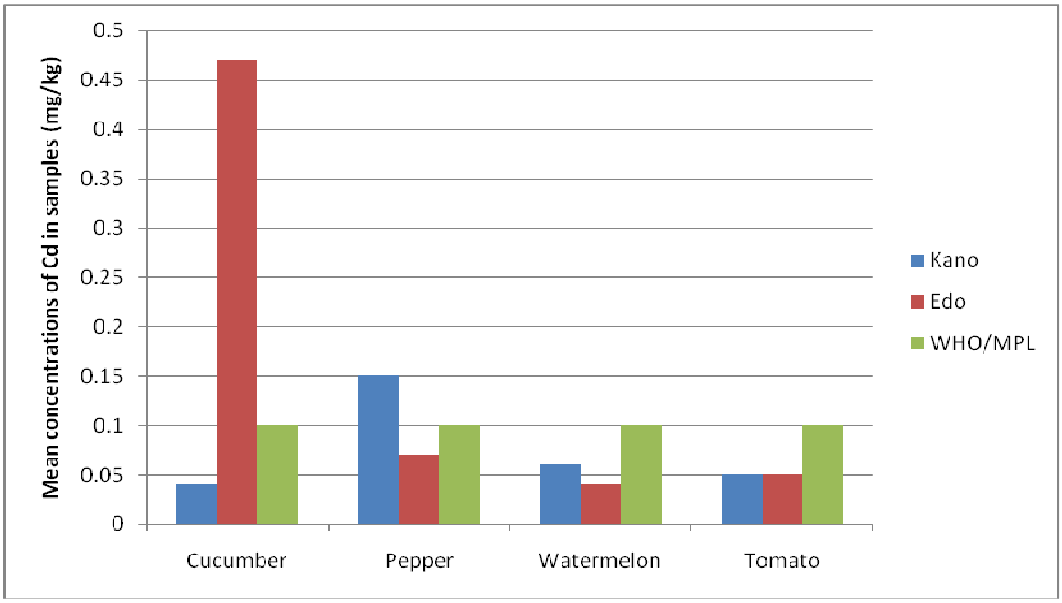

Fig. 2: Mean concentrations of Cd in samples from Kano and Edo states

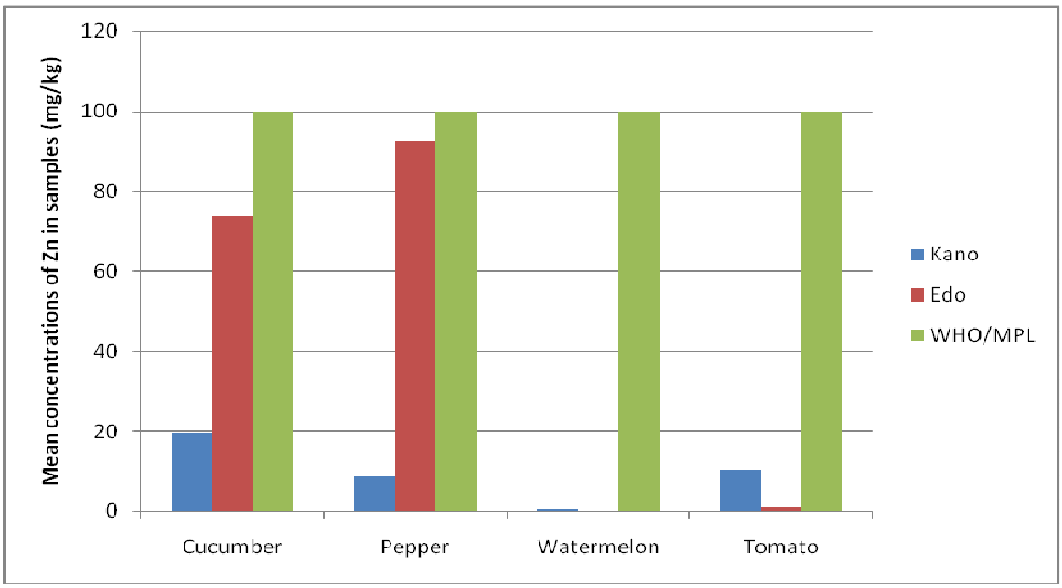

Fig. 3: Mean concentrations of Zn in samples from Kano and Edo states

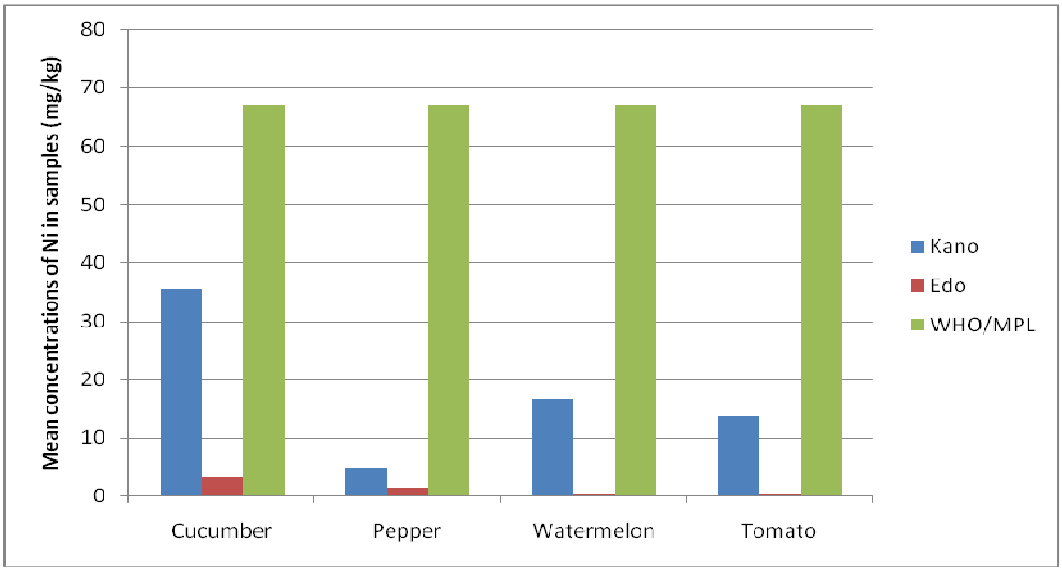

Fig. 4: Mean concentrations of Ni in samples from Kano and Edo states

From Figure 1, it is found that the mean lead concentration is highest in watermelon from Kano state and least in watermelon from Edo state. The mean lead concentrations in pepper, watermelon and tomato from Edo and Kano states were higher than the FAO/WHO (2001) maximum permissible limit of 0.3 mg/kg in edible vegetables. For cucumber however, the mean lead concentration was only higher than the FAO/WHO (2001) maximum permissible limit in samples from Kano state; those from Edo state were found to be lower than the FAO/WHO (2001) maximum permissible limit. It is generally observed that mean lead concentrations in samples from Kano were consistently higher than

those from Edo state. The presence of these metals can be attributed to various processes ranging from agricultural chemicals, laboratories and factories residues, and runoffs from road side mechanics. From Figure 2, it is found that the mean cadmium concentration is highest in cucumber and least in watermelon, both from Edo state. The mean cadmium concentrations in watermelon and tomato from Edo and Kano states are found to be higher than the FAO/WHO maximum permissible limit of 0.1 mg/kg in edible vegetables. For pepper and cucumber however, the mean cadmium concentrations are less than the WHO maximum permissible limit in samples from both Edo and Kano states; but higher than the FAO/WHO maximum permissible limit in pepper from Kano state and cucumber from Edo state. From Figure 3, it is found that the mean zinc concentration is highest in pepper and least in watermelon, both from Edo state. The mean zinc concentrations in pepper, watermelon, tomato and cucumber from Edo and Kano states were found to be lower than the FAO/WHO maximum permissible limit of 100 mg/kg in edible vegetables. From Figure 4, it is found that the mean nickel concentration is highest in cucumber from Kano state and least in watermelon from Edo state. The mean nickel concentrations in pepper, watermelon and tomato from Kano state are found to be consistently higher than the mean concentrations of nickel in the vegetables from Edo state. It is also found that the mean nickel concentrations in pepper, watermelon, tomato and cucumber from both Edo and Kano states are lower than the FAO/WHO maximum permissible limit of 67 mg/kg of nickel in edible vegetables.

The elevated levels of heavy metals found in these vegetables may be closely related to the contaminated soils and irrigation water, fertilizer and pesticides or due to the atmospheric deposition of metals on plant surfaces during their production, transportation and marketing as explained elsewhere (Mashi *et al*., 2014).The Uptake of heavy metals by crops is often affected upon the plant species, growth phase, type of the soil and metal species, soil condition, weather and environment (Richards *et al.*, 2000 and Chang *et al*., 1984). Moreover, the atmospheric depositions and marketing systems of vegetables play a significant role in elevating the levels of heavy metals in vegetables causing potential health hazards to the consumers as previous studies have shown (Osundiya *et al*., 2014, Chen *et al*., 2014; Mollazadeh *et al*., 2014; Sardar *et al*., 2013).

Conclusion

In this study, the concentrations of selected heavy metals in cucumber, watermelon, tomato and pepper from Kano and Edo states in Nigeria have been assessed and compared. The following conclusions can be drawn from this study:

- The mean concentrations of lead in samples from Kano state were higher than those from Edo state in all samples. They were also found to be considerably higher than the FAO/WHO maximum permissible limit.
- All samples were found to be safe for consumption in terms of the mean concentrations of zinc and nickel as

all samples were found to be within the FAO/WHO maximum permissible limit of zinc and nickel in vegetables.

- On account of its bioaccumulation, long term consumption of vegetables with heavy metal will be hazardous to human health.

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