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Research Article

Lead Concentration in Citrus Varieties and Soil from Orchards in Benue State, Nigeria

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Abstract

The concentration of lead in three citrus varieties and soil from orchards in Benue State was analyzed using atomic absorption spectrophotometer (AAS). The result of the analysis revealed the concentrations of lead in Washington (21353 µg/kg), Ibadan Sweet (65437 µg/kg), Valencia (62740 µg/kg) and the concentration of lead in soil (708600 µg/kg) respectively. The levels of Pb reported in the three citrus varieties are above the WHO/FAO permissible limits in citrus fruits (100 µg/kg) in all the samples analyzed. The values of Pb detected in the soils analyzed are below the WHO/FAO (90000 µg/kg) limits of Pb in agricultural soils.

Keywords: Soil; Lead; Atomic Absorption Spectrophotometer; Ibadan Sweet; Valencia.

Introduction

Heavy metals occur naturally in the earth crust, they are mostly persistent in the environment because they cannot be easily degraded. These metals enter the human body system through food, air, water and also they bioaccumalate in the body system [1]. These bioaccumulations could be over a period of time due to their long half-lives. Their potential for accumulation in the different organs of body thus leads to unwanted side effects [2]. Heavy metal contaminations threaten agriculture practices such as poor vegetation growth and lower plant resistance against forests pests [3]. Fresh fruits are very important protective foods useful for the maintenance of health as well as the prevention and treatment of various diseases [4]. Inadequate intake of fruits may result into cardiovascular diseases and possible cancers [5].

Generally, plants have shown a great ability to accumulate these metals from the environment [6]. The bio - toxic effects of heavy metals cannot be over-emphasized and individual metals exhibit specific signs of their toxicity. The consumption of fruits from plants produced in contaminated areas in addition to ingestion or inhalation of contaminated particles could elevate the levels to humans [7]. Metal analysis in environmental samples such as soils and plants are important indices for monitoring environmental pollution [8].

Benue State is known for its agricultural activities, agrochemicals are applied on the citrus trees and these have the potential of changing the composition, texture, storage time and could perish due to the presence of heavy metals and may affect local consumption, export and human health [9]. This research work will provide a reference and comprehensive data base on lead (Pb) in citrus varieties and soil since it is the first time such a research is been conducted covering the entire State and this research is aimed at determining the levels of lead in citrus varieties and soils in orchards from the twenty three local government areas of Benue State.

Materials and methods

Study area

The citrus fruit and soil samples from orchards were collected from 23 Local Government Areas of Benue State between November, 2018 to February, 2019 and the geographical coordinates are; 7º47´E and 10º0´E longitude, 6º25´N and 8º8´N latitude with an area of 34,059 km^2. The number of samples collected in order to achieve a good precision was determined using equation (1) below:

Determination of number of samples to be taken

The number of samples needed for this work was determined using eq. (1).

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$$n = \frac{Z^2 \times P \times 1-P}{C^2} \quad (1)$$

where
Z = Z value (e.g. 1.96 for 95% confidence level)
P = percentage picking a choice, expressed as decimal (0.5) used for sample size needed
C = confidence interval, expressed as decimal
n = sample size

Sample collection

The citrus fruits varieties (Washington, Ibadan Sweet and Valecia) with average weights of 234 ± 15, 145 ± 12 and 126 ± 18 were collected from the twenty three (23) Local Government Areas of Benue State from which the orchards were located from three (3) council wards of each Local Government where the citrus fruit samples were taken and bulked based on varieties to a total of sixty nine (69) composite samples for analysis. Equally, three soil samples were taken from the orchards and transferred into polythene bags and transported to the laboratory. The soil samples were placed on a plastic tray and spread to air-dry. The soil samples were redistributed twice daily for two weeks for effective drying. When dried, the soil samples were grounded in a mortar and sieved through 2 mm pore sieve size into plastic containers and stored for subsequent analysis.

Laboratory procedures

The citrus fruits were washed with tap water and then with distilled water after which the juice were squeezed into separate beakers. About 200 mL of juice were obtained from each sample. The juice were filtered, mixed well and 1.0 g of the sample juice and soil were weighed out on a weighing balance and put in a beaker and 10 mL of a mixture of nitric acid (HNO_3) and perchloric acid ($HClO_4$) in the ratio (4:1) were added to each sample and heated on a hot plate in a fume chamber until all the fumes were given off. Then the digested samples were allowed to cool and acidified with 10 mL of 1:1 mixture of HCl: H_2O, filtered and transferred to a 100 mL volumetric flask and made up to mark with deionized water [10]. The digested samples were transferred into plastic bottles and taken for AAS analysis.

Soil sample treatment for the determination of lead

Digestion was performed, following the procedure recommended by the [11]. One gram (1.0 g) of the soil sample was placed in a 250 mL digestion tube and 10 mL of concentrated HNO_3 was added. The mixture was boiled gently for 30 – 45 minutes to oxidize all easily oxidizable matter. After cooling, 5 mL of 70 % $HClO_4$ was added and the mixture was boiled gently until dense white fumes appeared. After cooling, 20 mL of distilled water was added and the mixture was boiled further to release any fumes. The solution was cooled, further filtered and transferred quantitatively to a 100 mL volumetric flask by adding distilled water [12].

Statistical analysis

Statistical package for Statistical Analysis System (SAS Version 2017) was employed to determine if there is any correlation in the concentrations of lead between soil and citrus varieties.

Results and discussion

The results of the analysis shows the concentration of lead in the three citrus varieties and all the soil samples from the orchards in Benue State in the period under investigation in figures 1 to 3 and 4 to 6 respectively.

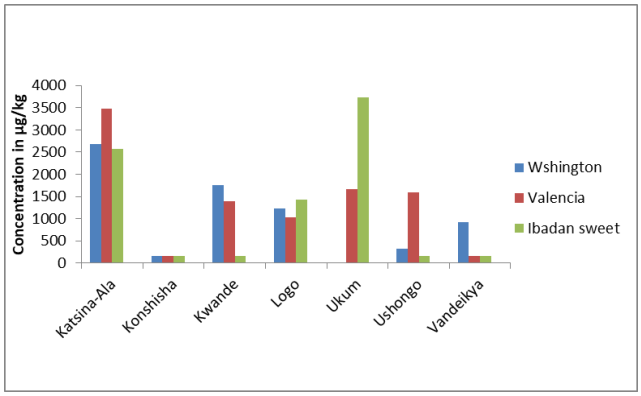

Figure 1. Concentration of Pb in citrus varieties in some LGA in Benue state

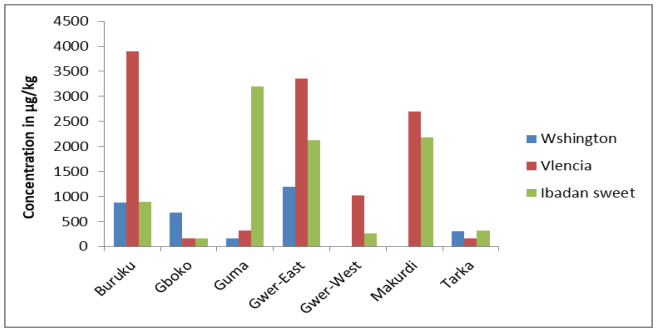

Figure 2. Concentration of Pb in citrus varieties in some LGA in Benue state

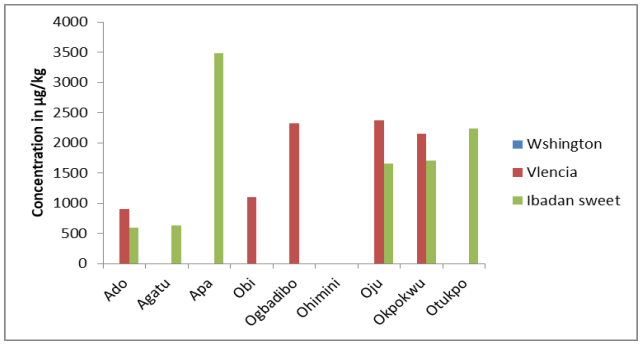

Figure 3. Concentration of Pb in citrus varieties in some LGA in Benue state

The result of the analysis shows the level of Pb to be higher in Ibadan Sweet compared to the other two citrus varieties (Valencia and Washington). The concentration of Pb in orange from farm in Kaani, Bori was reported to be 5800 µg/kg [10] higher than the values recorded in this work. The concentration of Pb in oranges in selected markets in Lagos, Nigeria reported Pb concentration value of 149 µg/kg [5] lower than the values recorded in the three orange varieties studied probably as a result of the nature of soil, climate and may not be subjected to chemical treatment. The concentration of Pb in citrus species cultivated on road side in Uyo metropolis in Akwa Ibom State, Nigeria reported Pb value of 1750 µg/kg [7] lower than the values recorded in this analysis.

The levels of Pb reported in the three citrus varieties are above the WHO/FAO permissible limits in citrus fruits (100 µg/kg) in all the samples analyzed. The trend of accumulation of Pb in the orange juice are, Ibadan sweet > Valencia > Washington. The variation in Pb distribution in the oranges could be due to variety, the soil pH, solubility in soil, translocation rate, the amount and type of agrochemicals applied. The trend of accumulation in the varieties explained the fact that Ibadan sweet and Valencia are cultivated on large scale by farmers because they produce year round and receive more treatment chemically.

The average level of Pb in the soil samples from orchards in Benue State analyzed is 708600 µg/kg. High values of Pb in the range of 400 – 32600 µg/kg in soils around Wurukum Abattoir were reported [13]. High levels of Pb in the range of 283000 – 665000 µg/kg were reported in soils around mechanic workshop in Benue State, Nigeria [14]. High levels of Pb were reported in municipal dumpsite soils in the range of 118000 – 4548000 µg/kg [15]. Pb levels were reported in old mining sites in Jos Plateau State in the range of 10 – 430 µg/kg [16] which are higher than the values recorded in this research. The values of Pb detected in the soils analyzed are below the WHO/FAO (90000 µg/kg) limits of Pb in agricultural soils.

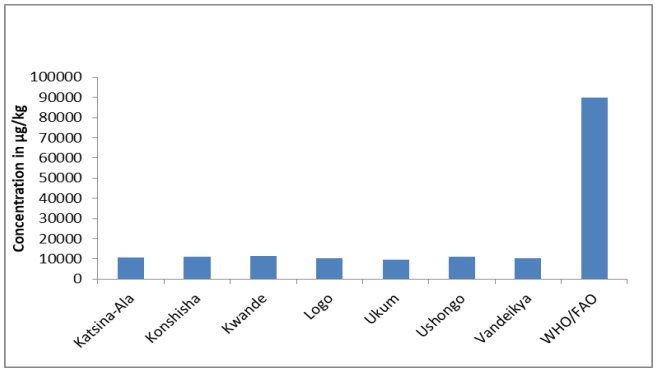

Figure 4: Concentration of Pb in soil in some LGA in Benue state

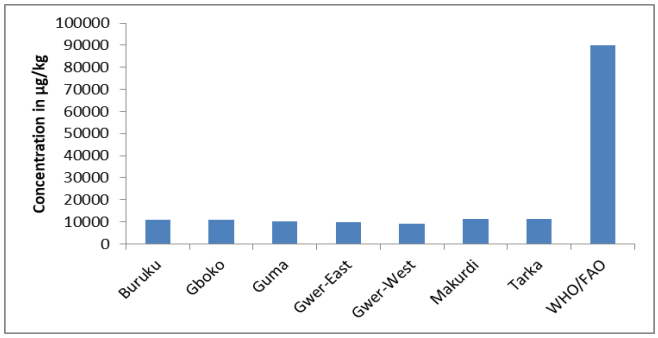

Figure 5: Concentration of Pb in soil in some LGA in Benue state

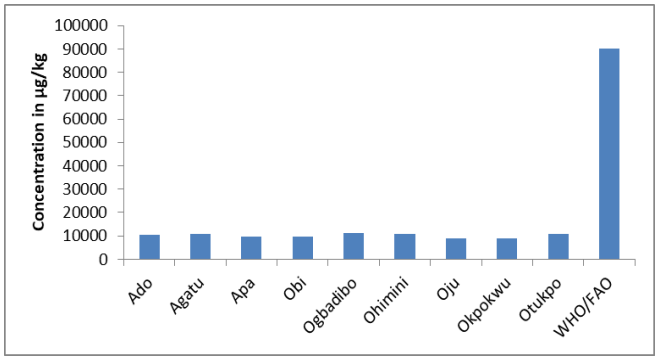

Figure 6. Concentration of Pb in soil in some LGA in Benue state

Conclusions

The concentrations of lead (Pb) in the three citrus varieties were comparably higher with similar samples from other published works cited and WHO/FAO permissible limits in citrus fruits (100 µg/kg). Relatively, the concentrations of Pb in the orchard soils were below the WHO/FAO (90000 µg/kg) limits in agricultural soils. The concentrations of Pb in soils from

citrus orchards are not significantly different from that in control, suggesting that chemical treatment on these plantations does not affect the soil with regard to Pb levels. This work shows that these citrus varieties could be used as excellent bio-indicator of lead in the terrestrial environment as the concentration of lead is higher than the permissible limits in the citrus varieties than the surrounding soils and is a concern because of the considerable amount recorded in these citrus varieties.

Conflict of interest

The authors declare no conflict of interests.

References

[1] Otitoju O, Akpanabiatu MI, Otitoju GTO, Ndem JI, Uwah AF, Akpanyung EO, Ekanem JT. Heavy metal contamination of green leafy vegetabble gardens in Itam road construction site in Uyo, Nigeria. Res J Environ Earth Sci 2012;4:371-75.

[2] Aderinola OJ, Clarke EO, Olarinmoye OM, Kusemiju V, Anatekhai MA. Heavy metals in surface water, sediments, fish and perwinkles of Lagos, Lagoon. American-Eurasian. J Agric Environ Sci 2009;5:609-17.

[3] Omoyajowo KO, Njoku KL, Babalola OO, Adenekan OA. Nutritional composition and heavy metal content of selected fruits in Nigeria. J Agric Environ Int Dev 2017;111:123-39.

[4] Mausi G, Simiyu G, Lutta SAssessment of Selected Heavy Metal Concentrations in Selected Fresh Fruits in Eldoret Town, Kenya. J Environ Earth Sci 2014;4:1-8.

[5] Rotimi OT, Ogunyebi AL, Fingesi TS. Evaluation of Heavy Metals Level and Proximate Analysis of Common Fruits from Selected Markets in Lagos, Nigeria. J Appl Sci Environ Manage 2018;22:791-95.

[6] Khairiah J, Zalifah MK, Yin YH, Aminah A. The uptake of heavy metals by fruit type vegetables grown in selected agricultural areas. Pak J Bio Sci 2004;7(8):1438-42.

[7] Udo NS, Okon OG. Heavy Metal Concentrations of Citrus Species (Citrus reticulata and Citrus sinensis) Cultivated on Road Sides in Uyo Metropolis in Akwa Ibom State, Nigeria. Int J Eco Sci Environ Eng 2017; 4: 86-92.

[8] Ubom RM, Ogbemudia FO, Benson KO. Soil-Vegetation Relationship in Fresh Water Swamp Forest. Sci J Bio Sci 2012; 1:13-16.

[9] Suthida A, Sirikhwan T. Effects of types and amount of stabilizers on physical and sensory characteristics of cloudy ready-to-drink mulberry fruit juice. Food Sci Nut 2015;3(3):213-20.

[10] Kalagbor I, Diri E. Evaluation of heavy metals in orange, pineapple, avocado pear, and pawpaw from a farm in Kaani, Bori, River State Nigeria. Int Res J Pub Environ Health 2014;4:87-94.

[11] AOAC official methods of analysis.15th eds. Association of Official Analytical Chemists, Arlington, Virginia, 1990; pp. 84-85.

[12] Blancher RW, Rehim G, Caldwell ACSulphur in plant materials by digestion with nitric and perchloric acids. Soil Sci Soc Am Proc 1965;29:71-2.

[13] Ande S, Famuyiwa A, Iorungwa MS. A preliminary assessment of heavy metals in top soils around Wurukum Abbatoir, Makurdi, Benue State, Nigeria. Int J Sci Res 2015;6:144-7.

[14] Pam AA, Sha'Ato R, Offem JO. Evaluation of heavy metals in soils around auto-mechanics workshop clusters in Gboko and Makurdi, Central Nigeria. J Environ Chem Ecotoxicol 2013;5:298-306.

[15] Ediene VF, Umoetok SBA. Concentration of heavy metals in soils at the municipal dumpsite in calabar metropolis. Asian J Environ Ecol 2017;3:1-11.

[16] Joseph DO, Egila JN, Salami SJ. Determination of the contamination levels of cadmium, lead, arsenic and mercury in the vegetables from old mining site of Jos plateau, Nigeria. Int J Interdipl Res and Inn 2016;4:40-4.

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