International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Comparative Study of Heavy Metal Concentration in *Capsicum Annum* (Pepper) Cultivated in North Eastern Nigeria

M. Waziri[1], I. A. Adamu[2]

Department of Chemistry, Yobe State University, P.M.B. 1144, Damaturu, Nigeria

Abstract: ***Yaji is a popular spice used in most parts of Northern Nigeria, prepared by mixing powdered Capsium annuum (pepper) and seasoning to taste or mixing powdered Capsium annuum (pepper), with other vegetables like ginger, garlic and seasoning. Consumers claim yaji add taste and stimulates appetite when added to cooked foods and edible leafy vegetables. Consumption of vegetables containing heavy metals is a major pathway for heavy metal accumulation in human body which can lead to health risks. The aim of this study was to assess and compare the concentrations of Pb, Cr, Zn, Mn and Fe in Capsium annuum (pepper) grown in Gashu'a (Yobe State), Biu (Borno State) and Yamaltu deba (Gombe State) of North Eastern Nigeria. Atomic Absorption Spectrophotometric techniques was used for the investigation and the result showed the following variations in levels the heavy metals in the tested samples; 0.03±0.002mg/kg – 1.0±0.02 mg/kg Cr, 3.0±0.05mg/kg – 3.5±0.10mg/kg Zn, 0.1±0.01mg/kg –14.00±0.10mg/kg Mn, 1.30±0.01mg/kg – 3.440±0.50mg/kg Fe and 0.1±0.01mg/kg – 0.5±0.10mg/kg Pb. The samples from Gombe showed high accumulation of Pb, Mn and Cr compared to the other samples but all samples were found to be within the recommended dietary intakes for metals in foods defined by the Food and Drug Administration/World Health Organization (FAO/WHO). However, continuous consumption of pepper can contribute to the body burden of the metal toxins especially Pb and Cr.***

Keywords: Accumulation, Heavy metals, Pepper, Vegetables, *Yaji*

1. Introduction

The accumulation of heavy metals in agricultural soils is of increasing concern due to the food safety issues and potential health risks not only on crop plants but also on human health as well as its detrimental effects on soil ecosystems [1]. Some of these metals are naturally present in substantial amounts through weathering of rocks and soils. High levels of heavy metals in fruits and vegetables have been reported in areas with long term use of wastewater [2], [3]. However, anthropogenic activities have been reported to be the major sources of heavy metals distribution in vegetables, fruits and soils [4].

Consumption of vegetables and fruits in Northern Nigeria has increased in recent years due to the awareness that they contain certain nutritionally important compounds necessary for safeguarding human health. Studies have shown that vegetables contain phytochemicals which categorized them as 'protective food' as they function in prevention and curing diseases in human [5], [6].

Vegetable uptake of heavy metals from soil is one of the major pathways that metals accumulate to high concentrations causing serious risk to human health when consumed [7]. The toxicity of heavy metals depends on a number of factors such as the type of metal, the amount absorbed, and the route of exposure as well as the extent of exposure, acute or chronic. The age of the person can also influence toxicity. For example, young children are more susceptible to the effects of lead exposure because they absorb several times the percent ingested compared with adults and even brief exposures can influence developmental processes [8]. Some of the health effects of high level of heavy metals in vegetables and fruits on human include; gastrointestinal disorder, damage to reproductive, renal and central nervous systems [3], [9].

Capsicum annum (Pepper) is a very popular spice grown and consumed in most parts of Nigeria especially in the Northern Nigeria. *Yaji* is a local name for the spice prepared from pepper and used in most parts of Northern Nigeria. It is usually added to cooked foods and edible leafy vegetables such as lettuce, cabbage, garden cress etc. and consumers claim that it stimulates appetite and add taste to food.

Pepper like most vegetables and fruits cultivated in North Eastern Nigeria are grown in the areas of study through irrigation farming, and farmers usually use fertilizers and plant nutrients to boast production thereby exposing the plant to heavy metal contamination. The habit of adding *'yaji'* that may be contaminated with heavy metals to food may lead to accumulation of these metals in human organs and can affect the consumers' health.

The concentrations of some heavy metals (Pb, Cr, Zn, Mn and Fe) will be determined in the pepper (small pepper) grown in Yobe, Borno and Gombe States of Northeastern Nigeria with the aim of evaluating the potential dietary toxicity by comparing the levels obtained with the recommended dietary allowances for metals in fruits. The heavy metal concentrations in the samples will also be compared for significant differences between locations. The findings is expected to serve as a guide to the consumers on the possible risk involved in eating pepper and the need to avoid certain varieties or/and eat others with moderation in order to safeguard their health.

2. Materials and Methods

2.1 Sampling

Fresh pepper (C*apsicum annum*) samples were collected from the agricultural sites of Yamaltu deba (Yamal) in Gombe State, Biu irrigation farm (Biu) in Borno State and Fadama area of Gashu'a (Gsh) in Yobe State.

2.2 Sample Preparation

Samples were cleaned and oven-dried at 80^0C for about 72 hours before chemical analysis. The dried samples were ground in a mortar with pestle, sieved with a 0.5 mm mesh to obtain a fine powder. The dried samples were digested by wet digestion method as described by Dean, 2003 [10].

2.3 Determination of heavy metal concentrations in the samples

The concentrations of Fe, Pb, Zn, Mn and Cr in each sample was determined using Atomic Absorption Spectrophotometer. The procedures used for each parameter were as contained in the manufacture's manual for the equipment.

3. Results

Variations in mean concentration of the heavy metals (Fe, Pb, Zn, Mn and Cr) in the pepper samples from various locations are presented in Figures 1 to 3 while the levels of each of the investigated heavy metals at the studied locations were compared and shown in Figure 4.

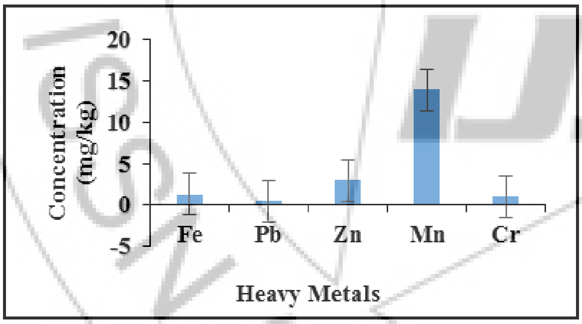

Figure 1: Variation in mean concentrations of Heavy Metals in pepper samples from Yamaltu Deba (Gombe)

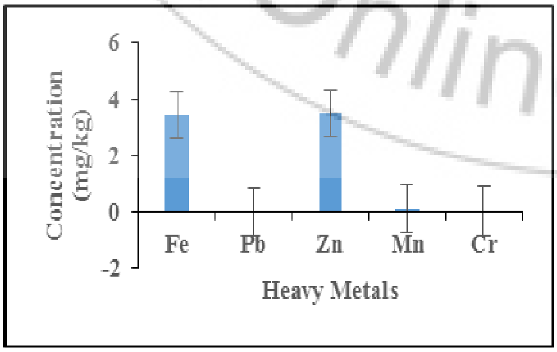

Figure 2: Variation in mean concentrations of Heavy Metals in pepper samples from Gashua (Yobe)

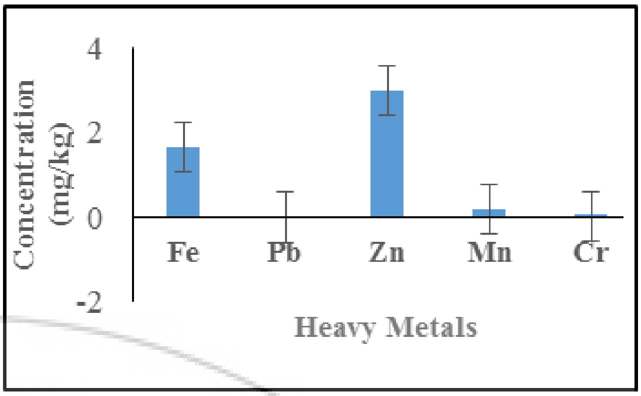

Figure 3: Variation in mean concentrations of Heavy Metals in pepper samples from Biu (Borno)

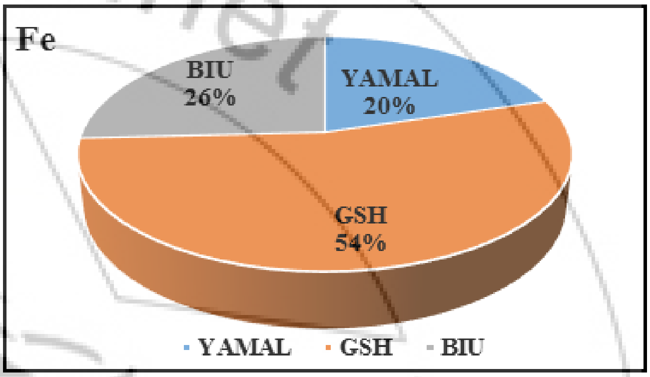

Figure 4a: Comparison of Fe concentration in the pepper samples

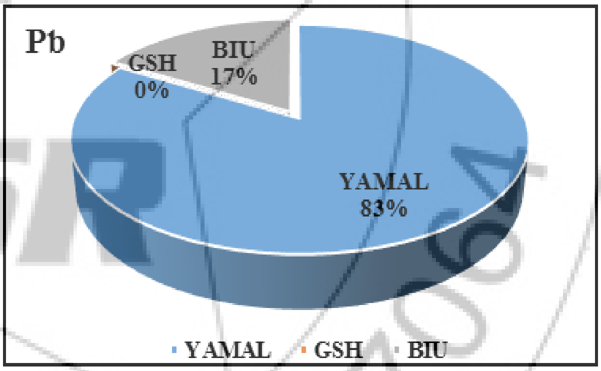

Figure 4b: Comparison of Pb concentration in the pepper samples

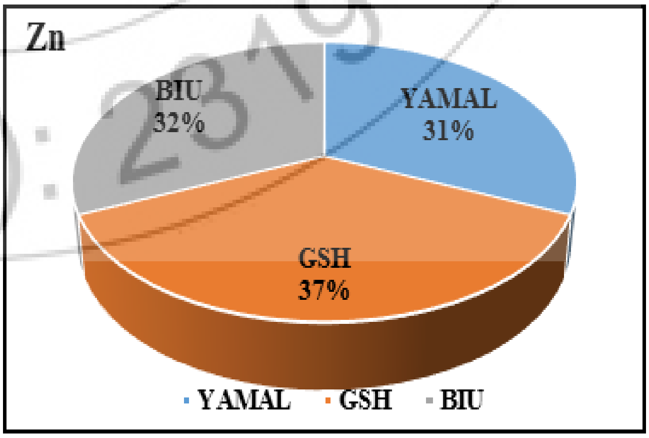

Figure 4c: Comparison of Zn concentration in the pepper samples

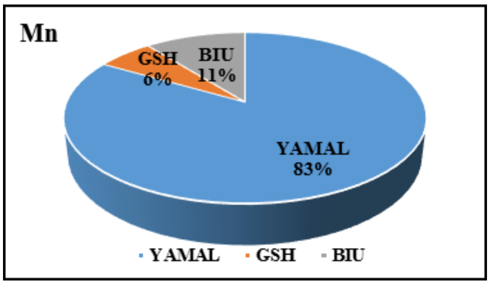

Figure 4d: Comparison of Mn concentration in the pepper samples

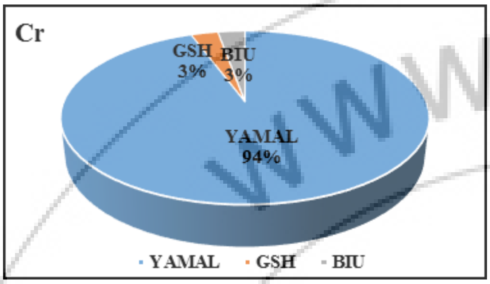

Figure 4e: Comparison of Cr concentration in the pepper samples

4. Discussion

The levels of heavy metals in the pepper samples from Yamal deba ranged between 0.5mg/kg Pb to 14mg/kg Mn (Fig 1). Pb was not detected in pepper samples from Gashua and trace amounts were recorded in Biu samples. The levels of Pb in Biu sample were within the safe limits as described by FAO/WHO (1995) [11] but the level of Pb in Yamal deba samples exceeded the safe limits for Pb (0.3mg/kg) and can pose severe health effects. Similar high values were recorded in waste water grown vegetables [12], [13]. Fruits and vegetables are among the major sources of lead, supplying most of the intake in the diet [14]. Lead affects the red blood cells and causes damage to organs including the liver, kidneys, heart, and male gonads, as well as the immune system. Comparison of the levels of Pb (Fig. 4b) revealed that the Yamal samples shows highest concentration which constitute 83% while samples from Gashua showed least concentration range (0%). Thus, Pb showed the following order of concentration; Yamal > Biu >Gashua. Statistically significant differences ($p < 0.05$) between locations were also observed.

Zinc and Iron are essential metals and cofactors of many enzymes. However, high or low intake of these metals can cause deficiencies or toxic effects [15]. Though high levels of Zn and Fe were recorded at Gashua and Biu (Figs. 2, Fig. 4a and Fig. 4c) compared to the other samples but the levels were lower than the FAO/WHO limits for vegetables and the differences between samples from the different locations were insignificant. Similar concentrations of Zn and Fe were observed in root and leafy vegetables [7].

Mn is an essential element but high level of Mn has been shown to cross the blood-brain barrier and can cross the placenta during pregnancy thereby affecting the fetus [9]. The pepper samples from Yamal deba showed highest accumulation of Mn (14.0mg/kg) (Fig. 1), which was above the safe permissible limits for human consumption and higher than values reported for vegetables in literature [15], [16]. When compared to the samples from the other locations, Mn maintained similar variation in concentration as Pb though variations in the concentrations of Mn in Biu (11%) and Gashua (6%) samples were observed. (Fig. 4d). Significant differences (p< 0.05) were also observed between the samples from Yamal deba and the samples from the other locations.

Yamal deba pepper samples also showed more accumulation of Cr (0.1mg/kg; 94%) compared to the samples form Gashua (3%) and Biu (3%) (Fig. 4e) but all levels of Cr were within the stipulated limits for human consumption. Cr concentrations in vegetables and spices which were comparable to the present study were reported by Divirkli *et al*, 2006 [17]. Higher levels of Pb and Cr in pepper samples were reported by Awode *et al.* 2008[18]. They reported that the uptake of heavy metals by the pepper from soil may be responsible for the high levels of the metals. The variation of heavy metals in studied pepper samples may be due to variation in their absorption and accumulation tendencies.

5. Conclusion

The results from the present study revealed that all the pepper samples contained some amounts of heavy metals but the accumulation of the heavy metals were high in Yamal deba samples compared to samples from Gashu'a and Biu. The levels of Pb in Yamal deba samples were higher than the levels recommended by FAO/WHO. This suggest that long term consumption of pepper grown in Yamal deba may lead to severe risk to human health.

6. Recommendations

The manifestation of toxicity of ingested heavy metals is usually not immediate, it may take time due to the cumulative nature of heavy metals. As prevention is always better than cure, it is therefore recommended that if consumers must eat pepper, they should avoid pepper grown within Yamal deba. An urgent attention is also required to monitor and regulate the sources of Pb in that environment. The results of this study provide a baseline for future research. There is need to analyze the heavy metals content in the soil of the study area to assess the possibilities of transfer of heavy metals from soil to vegetable. The sources of the heavy metals should also be determined and the health risk evaluated.

7. Acknowledgment

The authors are grateful to the zonal office of the National Food Drug Administration and Control (NAFDAC) Maiduguri, Nigeria for their assistance during the period of analysis.

References

[1] Weigert, P. "Metal Loads of Food of Vegetable Origin Including Mushrooms. In: Metals and Their Compounds

in the Environment, Occurrence, Analysis and Biological Relevance" Merian, E. (Ed.). VCH, Weinheim, 1991, Pp.: 458-468

[2] Arora, M., Bala, K., Shweta, R., Anchal, R., Barinder, K., and Neeraj, M."Heavy Metal Accumulation in Vegetables Irrigated with Water from Different Sources. *Food Chemistry*. 2008, 111:811- 815

[3] Qadir, M., Wichelns, L.D., Raschid-Sally, P.G., McCornick, P.D., Bhari, A. and Minhas, P.S."The challenges of wastewater irrigation in developing countries". *Agri. Water Manag.* 2008, 97:561-568.

[4] Cui, Y.J., Zhu, Y.g., Zhai, R.H., Chen, D.Y., Huang, Y.Z., Qiu, Y. and Liang, J.Z. "Transfer of metals from soil to vegetables in an area near a smelter in Nanning, China". *Environ. Int.* 2004, 30:785-791

[5] Maleki, A. and Masoud, A.Z. "Heavy Metals in Selected Edible Vegetable and Estimation of their Daily intake in Sanandaj, Iran". *Southeast Asian J. Trop Med Public Health*. 2008, 39:2.

[6] Edogo, H.O., Okwu, D.E., Mbaebie, B.O. "Phytochemicals constituents of some Nigerian medicinal plants". *Afr.J.Biotechnol.* 2005, 4(7): 685-688.

[7] Yeasmin, N.J., Ashraful, I. and Shawkat, A. "Transfer of metals from soil to vegetables and possible health risk". *Springer Plus*, 2013, 2: 385.

[8] Khariah, J., Zalifa M.K., Yin H.Y and Amina, A. "The uptake of Heavy Metals by Fruit Type Vegetables in Selected Agricultural Areas of Malaysia". *Pakistan Journal of Biological Sciences*, 2004, Vol.7, No.8, pp.1438-1442.

[9] USEPA. "USEPA- Integrated Risk Information System (IRIS) on Manganese". National Center for Environmental Assessment, Office of Research and Development, Washinton, DC, 1999.

[10] Dean, J.R. "Methods for Environmental Trace Analysis". John Wiley and Sons Ltd, London. 2003, Pp. 51-54

[11] FAO/WHO, "Evaluation of certain food Additives and Contaminants. Geneva, World Health Organization, Joint FAO/WHO Expert Committee on Food Additives, World Health Organization Technical Report Series," Vol.859, pp.29–35, 1995.

[12] Muchuweti, M., Birkett, J.W., Chinyanga, E., Zvauya, R., Scrimshaw, M.D. and Lester, J.N. "Heavy metal contents of vegetables irrigated with mixtures of wastewater and sewage sludge in Zimbabwe: Implications for human health". *Agri. Ecosystem Environ.* 2006, 112: 41-48

[13] Sawidis, T., Chettri, M.K., Papaionnou, A., Zachriasis, G. and Stratis, J. (2001). "A study of metal distribution from lignite fuels using trees as biological monitors". *Ecotoxicol. Environ. Safety*, 2001, 48:27-35.

[14] EU. "Assessment of the dietary exposure to arsenic, cadmium, lead and mercury of the population of the EU Member States. Brussels, European Commission, 2004. [Online] Available: (http://ec.europa.eu/food/food/chemicalsafety/contaminants/ [Accessed 10th September, 2014].

[15] Osma, E., Memduh, S., Zeliha, L. and Ahmet, A. "Assessment of heavy metal accumulation in vegetables and soils". *Pol. J. Environ. Stud.* 2013, 22(5): 1449-1455

[16] Audu, A.A. and A.O. Lawal,. "Variation in metal contents of plants in vegetable gardens sites in Kano metropolis". *J. Applied Sci. Environ. Manage.* 2005, 10: 105-109

[17] Divrikli, U., Horzum, N., Soylak, M. and Elci, L. "Trace heavy metal contents of some spices and herbal plants from western Anatolia, Turkey". *Int. Jour. Food Sci. Technol.* 2006, 41: 712-716

[18] Awode, E.A., Uzairu, A., Balarabe, M.L, Okunola, O.J. and Adewusi, S.G. "Levels of some Trace Metals in the Fadama soils and pepper (*Capsicum annuum)* along the Bank of River Challawa, Nigeria". *Asian Journal of Scientific Research*. 2008, 1:458-463