Research Journal of Environmental Toxicology

ISSN 1819-3420

Academic Journals Inc.

www.academicjournals.com

Research Journal of Environmental Toxicology 8 (2): 92-97, 2014
ISSN 1819-3420 / DOI: 10.3923/rjet.2014.92.97

Metal Contamination Of Foods and Drinks Consumed in Ota, Nigeria

[1]E.E.J. Iweala, [2]J.A.O. Olugbuyiro, [2]B.M. Durodola, [1]D.R. Fubara-Manuel and [1]A.O. Okoli

[1]Department of Biological Sciences, Biochemistry and Molecular Biology Unit,
[2]Department of Chemistry, Covenant University, P.M.B. 1023, Ota, Ogun State, Nigeria

Corresponding Author: E.E.J. Iweala, Department of Biological Sciences, Biochemistry and Molecular Biology Unit, Nigeria Tel: +234(0)8036738625

ABSTRACT

Food consumed in Ota, Nigeria are prone to contamination with environmental metal pollutants. The concentrations of lead (Pb), cadmium (Cd), nickel (Ni), mercury (Hg), copper (Cu), manganese (Mn) and zinc (Zn) were determined in some commonly consumed foods and drinks using Atomic Absorption Spectrophotometry (AAS). Samples selected included fried yam, fried bean cake (akara), roasted plantain (bole), roasted meat (suya), roasted fish, cassava flour (fufu), yam flour (amala), garri (eba), beans and herbal drink (agbo jedi jedi). Lead was present only in roasted meat (0.02±0.02 mg kg^{-1}), garri (0.04±0.06 mg kg^{-1}) and roasted plantain (0.004±0.01 mg kg^{-1}). Copper and cadmium ranged from 0.02±0.19-3.55±0.20 and 0.02±0.01-0.59±0.17 mg kg^{-1}, respectively. The mean concentration of zinc and nickel ranged from 0.09±0.10-1.19±1.52 and 0.04±0.01-6.38±7.61 mg kg^{-1}, respectively. The mean concentration of manganese ranged from 0.06±0.05-0.25±0.19 mg kg^{-1}. Manganese was absent in agbo jedi jedi (ethanolic). Some of the foods including roasted plantain (bole), roasted meat (suya), roasted fish, cassava flour (fufu), yam flour (amala) and beans were contaminated with nickel above FAO/WHO tolerable limits. Agbo jedi jedi was found to be contaminated with cadmium, nickel and copper above safety levels. Mercury was present only in roasted plantain at a level of 0.91±1.28 mg kg^{-1} which was beyond tolerable limits. This study indicates that consumers of the foods and drinks with high levels of metal contamination may be exposed to health risks associated with their presence.

Key words: Foods, drink, metals, contamination, toxicity

INTRODUCTION

Foods and drinks are generally consumed for several purposes aimed at growth, development and maintenance of good health. The contamination of foods and drinks by metals such as cadmium, manganese, copper, lead, chromium, mercury, zinc and nickel in areas with high anthropogenic pressure is widespread and is a major determinant of food quality (Ejaz ul Islam *et al.*, 2007). Some of these contaminants, especially the heavy metals, are cumulative poisons that pose potential hazards and toxicity (Jarup, 2003; Ellen *et al.*, 1990). Food contamination by heavy metals depends both on their mobility in the environment and bioavailability. Foods take up heavy metals by absorbing them from polluted environments (Zurera-Cosano *et al.*, 1989). Heavy metals may enter the human body through consumption of food contaminated with them (Cambra *et al.*, 1999). There is an increased awareness of the dangers and health risks associated with this type of contamination. This has necessitated a reduction in the maximum permissible limits of heavy metals in food and drink (Khan *et al.*, 2008; Radwan and

Salama, 2006). The increase in heavy metal contamination of foods in developing countries is due to the unregulated increase in urbanization and industrialization (Wong *et al*., 2003). These contaminants are usually released into the environment as a result of activities of industries, most of which lack the capacity to handle and dispose them appropriately. The biodegradable and chemical nature of the contaminants especially cadmium, copper and lead makes them persistent and easily deposited on foods and drinks (Singh *et al*., 2010; Sharma *et al*., 2008a, b; Haiyan and Stuanes, 2003). In Nigeria, the incidence of high thresholds of heavy metal contamination as a result of population growth, urbanization, dumping of wastes, agricultural and industrial activities have been reported in several cities (Ladigbolu and Balogun, 2011; Nubi *et al*., 2011). Ota is a semi-urban community situated about 10 km from Lagos that has a heavy presence of paint, aluminium, chemical, pharmaceutical and associated industries. The waste water and effluents from the anthropogenic activities of these industries release large amounts of metals into the environment which can easily be deposited on the foods and drinks that are usually prepared, exposed and hawked openly under unhygienic conditions. Common ready to eat and raw foods prone to metal contamination include fried yam, fried bean cake (akara), roasted plantain (bole), roasted meat (suya), roasted fish, cassava flour (fufu), yam flour (amala), garri (eba), beans and herbal drink (agbo jedi jedi) amongst others. The consequence of metal contamination of food can be hazardous to man which makes it imperative to monitor their presence in foods. The high level of pollution caused by heavy metals and the threat they pose to consumers and public health cannot be over emphasized. The aim of this study was to determine the concentration of metals with potential toxicity in foods and drinks consumed in Ota, Nigeria. This study will report the level of metal contamination in the foods and drinks and its associated harmful effects and suggest possible ways to reduce it.

MATERIALS AND METHODS

Collection of samples: Samples of foods and a herbal drink including fried yam, fried bean cake (akara), roasted plantain (bole), roasted meat (suya), roasted fish, cassava flour (fufu), yam flour (amala), garri (eba), beans and herbal drink (agbo jedi jedi) were collected from two major locations in Ota and Ogun State, Nigeria. Replicate samples of each food and drink were randomly purchased from major sales depots within the two locations between January and February 2013.

Preparation and digestion of samples: The samples were dried in an oven at 40°C and subsequently crushed with a mortar and pestle to a powdered form. Each sample (2.0 g) was put into digestion tubes and mixed with 10 mL each of nitric acid and perchloric acid. The digestion block was activated for 3 h at 45°C. The digested samples were cooled, diluted to 100 mL with distilled water and filtered into sample bottles.

Determination of heavy metals: Elemental determination of lead, cadmium, copper, mercury, nickel, zinc and manganese was done directly on the digested solutions using Perkin Elmer Analyst 300 Atomic Absorption Spectroscopy (AAS).

Statistical analysis: The mean and standard deviation of the results were done using SPSS. The results were expressed as Mean±SD.

RESULTS AND DISCUSSION

Concentrations of metals in the selected samples are represented in Table 1. The mean concentrations of zinc, nickel and manganese ranged from 0.19±0.01-1.08±0.23 mg kg^{-1},

Table 1: Metal levels in selected foods and drink

	Metal level (mg kg^{-1})						
Food	Zinc	Nickel	Lead	Manganese	Copper	Cadmium	Mercury
Fried yam	0.19±0.02	0.04±0.03	ND	0.06±0.05	0.16±0.02	0.01±0.01	ND
Fried bean cake (akara)	0.70±0.34	0.05±0.002	ND	0.21±0.01	0.22±0.04	0.02±0.003	ND
Roasted plantain (bole)	0.25±0.07	2.58±3.19	0.004±0.01	0.37±0.12	0.38±0.18	0.02±0.001	0.91±1.28
Roasted meat (suya)	1.19±1.52	0.83±1.06	0.02±0.02	0.25±0.19	0.28±0.14	0.02±0.01	ND
Roasted fish	0.81±0.21	0.12±0.13	ND	0.04±0.05	0.19±0.08	0.02±0.01	ND
Cassava flour (fufu)	0.09±0.10	1.51±2.11	ND	0.18±0.18	0.26±0.16	0.02±0.01	ND
Yam flour (amala)	0.24±0.01	0.73±0.96	ND	0.10±0.09	0.23±0.08	0.02±0.01	ND
Garri	0.19±0.01	0.04±0.01	0.04±0.06	0.10±0.02	0.25±0.01	0.02±0.01	ND
Beans	1.08±0.23	0.09±0.00	ND	0.45±0.17	0.02±0.19	0.02±0.17	ND
Herbal drink (agbo jedi jedi) (ethanolic)	0.58±0.26	1.53±0.54	ND	ND	3.12±0.16	0.39±0.05	ND
Herbal drink (agbo jedi jedi) (aqueous)	0.46±0.04	6.38±7.61	ND	ND	3.55±0.20	0.59±0.17	ND

Values are Mean±SD, n = 3, ND: Not detected

0.04±0.01-6.38±7.61 and 0.04±0.05-0.45±0.17 mg kg^{-1}, respectively. Copper and cadmium ranged from 0.02±0.19-3.55±0.20 and 0.02±0.01-0.59±0.17 mg kg^{-1}, respectively. Lead was present in only garri and roasted plantain at 0.04±0.06 and 0.004±0.01 mg kg^{-1}, respectively. The results show that beans contained the highest concentration of zinc and manganese, garri contained the lowest concentration of zinc while roasted fish contained the lowest concentration of manganese. The concentration of nickel was highest in the herbal drink (aqueous) and least in garri. Herbal drink (aqueous) also had the highest amount of copper and cadmium while beans contained the lowest concentration of copper. Mercury was present only in roasted plantain at a concentration of 0.91±1.28 mg kg^{-1}.

There are several reported cases of heavy metals pollution especially lead, iron, nickel, manganese, arsenic, chromium and copper in Nigeria (Dan'azumi and Bichi, 2010; Garba *et al.*, 2010; Ibeto and Okoye, 2010). Food consumed in Nigeria may be a major source of heavy metal toxicity in humans especially children (Galadima *et al.*, 2010). In this study, the concentration of the various heavy metals and others varied among the selected food samples. All the samples except the herbal drink contained cadmium concentrations lower than the maximum limits. Cadmium is one of the heavy metal that is of concern to human health in Nigeria as a result of its ease of contamination of foods (Galadima and Garba, 2012). Cadmium pollution is as a result of its use in alloys, pigments, metal coatings and batteries (Ladigbolu and Balogun, 2011; Ademoroti, 1996a, b). The source of cadmium in the herbal drink could be through contaminated water used in its preparation, since water sources in industrial areas are likely to be contaminated with it. Roasted plantain, roasted meat, roasted fish, cassava flour, yam flour, beans and the herbal drink had levels of nickel above FAO/WHO tolerable limits of 0.05 mg kg^{-1} b.wt. Nickel found in the soil, water, air and in the biosphere can easily contaminate food (Ladigbolu and Balogun, 2011; Ayodele and Gaya, 1994). High level of exposure to cadmium and nickel are associated with irritation of the eyes and respiratory passages, damage to brain, liver, bones and kidney, bronchitis, dermatitis, emphysema, hypertension, rickets and asthma (Galadima *et al.*, 2010). It is also associated with some cancers such as pancreatic cancer (Luckett *et al.*, 2012). Only roasted plantain contained high concentration of mercury well above the FAO/WHO maximum levels of 0.1 mg kg^{-1} b.wt. Mercury exposure can cause deleterious effects especially in young children and pregnant women. Effects in children include damage to central nervous system, endocrine system, kidneys and other organs. Long exposure may eventually result to death. Mercury is associated with teratogenic effects to fetuses and infants of women who have been exposed to it during pregnancy (Galadima and Garba, 2011). Other effects including erethism, irritability, excitability, insomnia, tremor fatigue and depression (Galadima *et al.*, 2010, 2011; Nubi *et al.*, 2011; Garba *et al.*, 2010). All the samples were within the FAO/WHO tolerable limits for copper except the herbal drink. Food and drinking water constitute major sources of copper exposure. Copper contamination of the herbal drink can also be traced to the use of contaminated water in its preparation. Even though, deficiency and toxicity are rare, chronic ingestion of high amounts of copper may result in liver dysfunction and other adverse effects (Brewer, 2010; Cockell *et al.*, 2008). All the samples except roasted fish had levels of manganese above the FAO/WHO tolerable limits. Manganese is an essential micronutrient but with potential for toxicity at very high levels (Martinez-Finley *et al.*, 2013). Manganese has been implicated in neurological toxicity and oxidative stress (Hsieh *et al.*, 2007; Ali *et al.*, 1995). Neurological toxicity is usually due to long term exposure and is characterized by behavioral changes including slow movements, tremors, facial muscle spasms, irritability, aggressiveness and hallucinations. Manganese may be considered a new environmental toxic pollutant with potential consequences for public health (Normandin *et al.*, 2002). The concentration of lead in all the selected samples was lower than the maximum levels of 0.2 mg kg^{-1}, recommended by FAO/WHO. Cases of lead poisoning especially amongst children in Nigeria are widespread. The exposure to lead can cause mental retardation, coma and eventual death. Symptoms associated with lead poisoning include constant headache, loss of appetite, vomiting, nausea, irritability and/or behavioural problem. The concentration of zinc in all the samples was within the tolerable limits recommended by WHO/FAO. Beans contained the highest concentration of zinc while garri contained the lowest concentration of zinc. Zinc enters the air, water and soil as a result of both natural processes and human activities such as metal manufacturing and zinc chemical industries, domestic waste water and run-off from soil containing zinc, disposal of zinc wastes from metal manufacturing industries and coal ash from electric utilities. Excessive absorption of zinc can suppress copper and iron absorption. The highest concentration in beans could be as a result of post harvest and handling operations including preservation with chemicals and storage in metallic containers. The knowledge of Zn toxicity in humans is minimal. The most important information reported is its interference with copper metabolism (Barone *et al.*, 1998). The symptoms that an acute oral Zn dose may provoke include tachycardia, vascular shock, dyspeptic nausea, vomiting, diarrhea, pancreatictis and damage of hepatic parenchyma (Salgueiro *et al.*, 2000). The biochemical mechanisms associated with metal toxicity especially copper, mercury, cadmium and nickel include depletion of glutathione, bonding to sulfhydryl groups of proteins and generation of reactive oxygen and nitrogen species (Abernethy *et al.*, 2010).

CONCLUSION

This study reveals the absence of potential lead contamination in the selected foods. However, some of the foods including roasted plantain, roasted meat, roasted fish, cassava flour, yam flour and beans were contaminated with nickel above the tolerable limits. It is important to note the high level of mercury contamination in roasted plantain, a common delicacy consumed in Nigeria. Also, the herbal drink which is consumed by a large segment of the populace supposedly for prevention and treatment of common ailments was found to be contaminated with cadmium, nickel and copper. Most of these foods are usually hawked or displayed in open containers under unhygienic conditions which make then prone to contamination with these metals. It is suggested that hygienic preparation, proper storage and display of these foods in covered containers may reduce contamination and prevent toxicity associated with the metals. Also appropriate regulation of industrial activities especially disposal of wastes should be enforced to reduce environmental contamination.

REFERENCES

Abernethy, D.R., A.J. Destefano, T.L. Cecil, K. Zaidi, R.L. Williams and USP Metal Impurities Advisory Panel, 2010. Metal impurities in food and drugs. Pharm. Res., 27: 750-755.

Ademoroti, C.M.A., 1996a. Levels of trace heavy metals on bark and fruit of trees in Benin city, Nigeria. Int. J. Environ. Pollut., 4: 241-253.

Ademoroti, C.M.A., 1996b. Environmental Chemistry and Toxicology. Foludex Press Ltd., Ibadan, Nigeria, pp: 162-181.

Ali, S.F., H.M. Duhart, G.D. Newport, G.W. Lipe and W. Slikker Jr., 1995. Manganese-induced reactive oxygen species: Comparison between Mn^{+2} and Mn^{+3}. Neurodegeneration, 4: 329-334.

Ayodele, J.T. and U.M. Gaya, 1994. Determination of lead in street dust to index its pollution in Kano municipal. Spectrum J., 1-2: 92-96.

Barone, A., O. Ebesh and R.G. Harper, 1998. Placental copper transport in rats: Effects of elevated dietary zinc on fetal copper, iron and metallothionien. J. Nutr., 128: 1037-1041.

Brewer, G.J., 2010. Toxicity of copper in drinking water. J. Toxicol. Environ. Health B. Crit. Rev., 13: 449-452.

Cambra, K., T. Martinez, A. Urzelai and E. Alonso, 1999. Risk analysis of a farm area near a lead- and cadmium-contaminated industrial site. J. Soil Contam., 8: 527-540.

Cockell, K.A., J. Bertinato and M.R. L'Abbe, 2008. Regulatory frameworks for copper considering chronic exposures of the population. Am. J. Clin. Nutr., 88: 863S-866S.

Dan'azumi, S. and M.H. Bichi, 2010. Industrial pollution and heavy metals profile of challawa river in Kano, Nigeria. J. Applied Sci. Environ. Sanitat., 5: 23-29.

Ejaz ul Islam, X.E. Yang, Z.L. He and Q. Mahmood, 2007. Assessing potential dietary toxicity of heavy metals in selected vegetables and food crops. J. Zhejiang Univ. Sci., 8: 1-13.

Ellen, G., J.W. van Loon and K. Tolsma, 1990. Heavy metals in vegetables grown in the Netherlands and in domestic and imported fruits. Zeitschrift Lebensmittel Untersuchung Forschung, 190: 34-39.

Galadima, A., N.U. Muhammad and Z.N. Garba, 2010. Spectroscopic investigation of heavy metals in waste water from University students' halls of residence. Afr. Sci., 11: 165-170.

Galadima, A. and Z.N. Garba, 2011. Recent Issues in Environmental Science. Including Incidences and Reports from Nigeria. Lap Lambert Academic Publishers, Germany, pp: 100.

Galadima, A., Z.N. Garba, L. Leke, M.N. Almustapha and I.K. Adam, 2011. Domestic water pollution among local communities in Nigeria: Causes and consequences. Eur J. Sci. Res., 52: 592-603.

Galadima, A. and Z.N. Garba, 2012. Heavy metals pollution in Nigeria: Causes and consequences. Elixir Pollut., 45: 7917-7922.

Garba, Z.N., S.A. Hamza and A. Galadima, 2010. Arsenic level speciation in fresh water from Karaye local government, Kano State, Nigeria. Int. J. Chem., 20: 113-117.

Haiyan, W. and A.O. Stuanes, 2003. Heavy metal pollution in air-water-soil-plant system of zhuzhou city, hunan province, china. Water Air Soil Pollut., 147: 79-107.

Hsieh, C.T., J.S. Liang, S.S.F. Peng and W.T. Lee, 2007. Seizure associated with total parenteral nutrition-related hypermanganesemia. Pediatr. Neurol., 36: 181-183.

Ibeto, C.N. and C.O.B. Okoye, 2010. High levels of heavy metals in blood of the urban population in Nigeria. Res. J. Environ. Sci., 4: 371-382.

Jarup, L., 2003. Hazards of heavy metal contamination. Br. Med. Bull., 68: 167-182.

Khan, S., Q. Cao, Y.M. Zheng, Y.Z. Huang and Y.G. Zhu, 2008. Health risks of heavy metals in contaminated soils and food crops irrigated with wastewater in Beijing, China. Environ. Pollut., 152: 686-692.

Ladigbolu, I.A. and K.J. Balogun, 2011. Distribution of Heavy Metals in Sediments of Selected Streams in Ibadan Metropolis, Nigeria. Int. J. Environ. Sci., 1: 1186-1191.

Luckett, B.G., L.J. Su, J.C. Rood and E.T. Fontham, 2012. Cadmium exposure and pancreatic cancer in South Louisiana. J. Environ. Public Health, Vol. 2012. 10.1155/2012/180186

Martinez-Finley, E.J., C.E. Gavin, M. Aschner and T.E. Gunter, 2013. Manganese neurotoxicity and the role of reactive oxygen species. Free Radic. Biol. Med., 62: 65-75.

Normandin, L., M. Panisset and J. Zayed, 2002. Manganese neurotoxicity: Behavioral, pathological and biochemical effects following various routes of exposure. Rev. Environ. Health, 17: 189-217.

Nubi, O.A., L.O. Oyediran and A.T. Nubi, 2011. Inter-annual trends of heavy metals in marine resources from the Nigerian territorial waters. Afr. J. Environ. Sci. Technol., 5: 104-110.

Radwan, M.A. and A.K. Salama, 2006. Market basket survey for some heavy metals in Egyptian fruits and vegetables. Food Chem. Toxicol., 44: 1273-1278.

Salgueiro, M.J., M. Zubillaga, A. Lysionek, M. Sarabia and R. Caro, 2000. Zinc as an essential micronutrient: A review. Nutr. Res., 20: 737-755.

Sharma, R.K., M. Agrawal and F.M. Marshall, 2008a. Heavy metal (Cu, Zn, Cd and Pb) contamination of vegetables in urban India: A case study in Varanasi. Environ. Pollut., 154: 254-263.

Sharma, R.K., M. Agrawal and F.M. Marshall, 2008b. Atmospheric deposition of heavy metals (Cu, Zn, Cd and Pb) in Varanasi City, India. Environ. Monit. Assess., 142: 269-278.

Singh, A., R.K. Sharma, M. Agrawal and F.M. Marshall, 2010. Risk assessment of heavy metal toxicity through contaminated vegetables from waste water irrigated area of Varanasi, India. Trop. Ecol., 51: 375-387.

Wong, C.S.C., X.D. Li, G. Zhang, S.H. Qi and X.Z. Peng, 2003. Atmospheric depositions of heavy metals in the Pearl River Delta, China. Atmos. Environ., 37: 767-776.

Zurera-Cosano, G., R. Moreno-Rojas, J. Salmeron-Egea and R.P. Lora, 1989. Heavy metal uptake from greenhouse border soils for edible vegetables. J. Sci. Food Agric., 49: 307-314.