ACTA SCIENTIFIC NUTRITIONAL HEALTH

Volume 3 Issue 2 February 2019

Research Article

Heavy Metal Levels in Locally Produced Rice in the South West Region of Nigeria

GTO Otitoju[1]*, O Otitoju[2], CP Ezenwa[1], BB Emmanuel Omale[3], RO Abdussalaam3 and JE Ali[3]

[1]Department of Nutrition and Dietetics, University of Nigeria Nsukka, Nigeria

[2]Department of Biochemistry, Federal University Wukari, Nigeria

[3]Department of Hospitality and Tourism Management, Federal University Wukari, Nigeria

***Corresponding Author:** GTO Otitoju, Department of Nutrition and Dietetics, University of Nigeria Nsukka, Nigeria.

Received: January 07, 2019: **Published:** January 29, 2019

Abstract

Rice (Oryza sativa) is a staple food in many countries of Africa and other parts of the world and it is the most important staple food for about half of the human race. Heavy metals occur naturally in the ecosystem, but rarely at toxic levels. They are persistent environmental contaminants since they cannot be easily degraded or destroyed. The study assessed heavy metal levels in locally produced rice in the South West region of Nigeria. The result showed that the concentration of lead ranged from 0.001-0.812mg/kg. The result also showed that the concentration of heavy metals: chromium, arsenic, cadmium and mercury could not be detected at less than 0.001mg/kg in any of the samples. Lead concentration of rice samples in Oyo State was 43% higher than that of Ogun state. The mean concentration of lead in all samples was found to be higher than the FAO/WHO recommended limit of lead in cereals. Hence, the consumption of these rice samples contaminated with heavy metals may result in accumulation of lead in the body, which may lead to different health problems such as cancer, cardiovascular disease, diabetes, auto immunity and also damage to different body organs.

Keywords: Heavy Metal; Rice; Toxicity; South West; Nigeria; Health

Introduction

Rice (Oryza sativa) is a staple food in many countries of Africa and other parts of the world. It is the most important staple food for about half of the human race [1]. Classified rice as the most important food depended upon by over 50 percent of the World population for about 80 percent of their food need. It is an increasingly important crop in Nigeria [2]. It is relatively easy to produce and is grown for sale and for home consumption. In some areas there is long tradition of rice growing, but for many, rice has been considered a luxury food for special occasions only. With the increased availability of rice, it has become part of the everyday diet of many in Nigeria. Heavy metals occur naturally in the ecosystem, but rarely at toxic levels. Heavy metals are persistent environmental contaminants since they cannot be easily degraded or destroyed; this is because they are stable [3]. They are absorbed by plants through the atmosphere, fertilizers, pesticides and deposition of urban and industrial waste on the soil and the water used to irrigate the plants [4]. Also mechanized farming and the use of fertilizers and chemicals are the current practices in agriculture. These practices are applied in the South West region of Nigeria in the cultivation of local rice in other to ensure food security. The consequences of these practices are environment contaminated by heavy meals from fertilizers, chemicals and fume from the machines. Crops grown on soils contaminated by heavy metals have greater accumulation of heavy metals compared to those grown on soils that are not contaminated. So, when humans consume any of these food sources, they are bound to absorb some of these heavy metals into their system [5]. Excess heavy metal accumulation in the environment has toxicological implication in humans, plants and other animals [6].

The accumulation of heavy metals in agricultural soils is a growing concern to the public as well as government agencies, due to the food safety issues and potential health risks as it has detrimental effects on soils ecosystems [7]. Heavy metals such as arsenic, cadmium, and mercury, are of primary concern in soil and

food contamination, particularly in rice cropping system, because of their toxicity [8]. Among heavy metals, mercury, Lead and Cadmium had been categorized as highly toxic [9]. Lead and cadmium even at low concentrations can be very harmful when ingested over a long time [10]. Metals such as lead, mercury, cadmium and copper are cumulative poisons, they cause environmental hazards and are reported to be exceptionally toxic [11].

These toxic elements accumulate in the soils, induce a potential contamination on food chain, and endanger the ecosystem safety and human health [12]. It has been specified that the dietary intake of food may be a major source of long term low level body accumulation of heavy metals and so the harmful impact of this becomes evident only after several years of exposure. Therefore, this study was aimed at determining the levels of heavy metals such as cadmium, mercury, arsenic, chromium and lead, present in locally produced rice in South West region of Nigeria.

Materials and Methods

Study area

The study was carried out in the South - Western part of Nigeria comprising of rice producing communities. They include Moloko Asipa in Obafemi Owode, of Ogun State (located within latitude 70N and longitude 3.50E), Igbemo of Ekiti state (latitude 7.50N and longitude 4.50E), Akpata of Oyo State (latitude 80N and longitude 40E). The samples were collected from rice growing locations with proper identification parameters (name and location).

Collection and treatment of samples

Rice samples were collected from different market locations in Ekiti, Oyo and Ogun State of Nigeria and put into different labeled polyethylene bags. The samples were transported to a Laboratory in the department of Home science, Nutrition and dietetics, University of Nigeria, Nsukka. The samples were washed with deionized water and spread on clean bagco bags to allow the water to drain off. The sample were packed into labelled brown envelops and dried in the Gallenhkamp oven at a temperature of 650C for two days. After drying, the samples were pulverized into fine powdery form. The rice samples were sieved using 2 mm sieve to obtain very fine particles.

Five gram (5g) of dried samples each was weighed into digestion flasks, 4ml perchloric acid and 8ml nitric acid were added to the respective flasks. The digestion flasks were then put on a hot plate set to 1200C (gradually increased) until the samples were all digested. After digestion the digested samples were diluted with distilled water appropriately in the range of standards which are prepared from stock standard solution of the metal [13,14]. Heavy metal concentrations in the samples were measured using a Perkin Elmer AS 3100 flame atomic absorption spectrophotometer facility from Divine Concept Laboratories Port Harcourt, Nigeria.

Statistical analysis

Means and standard deviations were calculated using the SPSS (statistical package for social sciences) software package (version 17).

Results and Discussion

The result of heavy metal analysis in locally produced rice from the South – Western part of Nigeria is presented in table 1. The result shows that lead concentration range from 0.001-0.812 mg/kg. The table shows that S43, Faro 46 rice sample from Akpata, Oyo State has the highest lead concentration. The lead concentration in rice samples from Oyo State ranges from 0.229-0.812 mg/kg, while that from Ogun State is 0.001-0.593 mg/kg and 0.0001-0.764 mg/kg for Ekiti state. It also shows that lead was not detected at < 0.001 mg/kg in S45, Nerica 8 rice sample, from Obafemi Owode, Ogun state.

Samples	Identity	MEAN (mg/kg)
S41	Ofada rice, Ofada, Ogun State	0.593 ± 0.002
S42	Igbemo rice, Igbemo, Ekiti State	0.764 ± 0.002
S43	Faro 46, Akpata, Oyo State	0.812 ± 0.002
S44	Faro 55, Akpata, Oyo State	0.229 ± 0.003
S45	Nerica 8, Obafemi Owode, Ogun State	ND

Table 1: Lead concentration in locally produced rice samples in the south-west region of Nigeria.

Mean ± S.D

ND- Not Detectable

Table 2 shows the mean lead concentration in rice samples, locally produced in South West region of Nigeria.

Heavy metal	MEAN (mg/kg)
Lead	0.480 ± 0.353

Table 2: Average of lead concentration from locally produced rice samples from the South West region of Nigeria.

Mean ± SD

The result indicates that the mean of lead concentration in the five rice samples is 0.480 mg/kg.

Table 3 shows the mean lead concentration of lead in rice samples from same location in the South West region of Nigeria. It shows that the mean concentration of lead in rice samples in Oyo state (S43, Faro 46 and S44, Faro 55) is 0.521mg/kg and that of Ogun state (S41, Ofada rice and S45, Nerica 8) is 0.297mg/kg. It also revealed that the mean concentration of lead in rice samples in Oyo State is higher than that of Ogun State. Lead concentration of rice samples in Oyo State was 43% higher than that of Ogun state.

	MEAN (mg/kg)
OYO STATE (S43 and S44)	0.521 ± 0.412
OGUN STATE (S41 and S45)	0.297 ± 0.419

Table 3: Average of lead concentration from locally produced rice samples from same location in the South West region of Nigeria.

Mean ± SD

The result also shows that the concentration of heavy metals: chromium, arsenic, cadmium and mercury could not be detected at less than 0.001 mg/kg in any of the samples.

It has been increasingly recognized that the composition of a diet consumed is an important determinant to the health of an individual, community, nation or country. For a healthy nation, very good nutrition is required to achieve that. Engaging in the appropriate nutrition, healthy for one, requires variety in the food consumption.

The mean concentration of lead in Ofada rice, Igbemo rice, Faro 46, Faro 55 and Nerica 8 from Ogun, Ekiti and Oyo state are 0.593, 0.764, 0.812 and 0.229 mg/kg respectively. The lead concentration in the samples were in this order, Faro 46 > Igbemo rice > Ofada rice > Faro 55 > Nerica 8. This showed that Faro has the highest lead concentration with the average of 0.812 mg/kg. Individuals consuming rice produced in this region will be consuming more than the Provisional Tolerable Weekly Intake (PTWI) of lead, which is 0.0025 mg/kg body weight [15]. The concentration of lead in Nerica 8, is below detectable concentration of heavy metals at <0.001 mg/kg. Bioavailability of heavy metals is mainly affected by total content of soil chemical and physical properties and plant species [16]. Therefore, Nerica 8 could be said to have an undetectable lead concentration because of the low concentration of lead in the soil on which it was cultivated and, in the water, used for irrigation or that the lead absorbed by the rice plant is in the roots, since the root of rice plant contains more heavy metals absorbed than the grains [17].

The result indicated that the mean concentration in the five samples from the South West is 0.480mg/kg. This value is still much higher than the Provisional Tolerable Weekly Intake (PTWI) of lead, which is 0.0025mg/kg per body weight, this is risky to health [18].

Comparing the lead concentration of samples from same location, it revealed that the lead concentration of the rice samples From Oyo State on the average is 0.521mg/kg, which is 43% greater than the lead concentration of samples from Ogun state, of which is 0.297 mg/kg on the average. Hence, continual consumption of rice from Oyo state over a period of time will result in a high absorption of lead in the body.

Rice grain could take up less heavy metal than edible vegetable with the exception of mercury [17]. This is because most heavy metals often confined in the roots after paddy plant uptake. But other than roots uptake, straws and grains also show competence in the absorption of heavy metals. For the five toxic heavy metals, absorption by rice plant has the relation: roots > straw > grain. The result showed that rice transport mercury, chromium, arsenic, and cadmium very weakly to the grains and lead very easily to the grains.

Conclusion

This study was able to analyze the different rice samples, locally produced in the South West region of Nigeria. It showed that lead is the only detectable heavy metal and it is found in high concentration. Hence, lead is a primary heavy metal contaminant of local rice, used in this study. The mean concentration of lead in all samples was found to be higher than the FAO/WHO recommended limit of lead in cereals. The consumption of these rice samples contaminated with heavy metals will result in accumulation of lead in the body, which will lead to different health problems such as cancer, cardiovascular disease, diabetes, auto immunity and also damage to different body organs. The accumulation of these heavy metals in our plants and soil is as a result of environmental pollution from globalization and industrialization.

Recommendation

Heavy metals are silent killers, they enter the body by digestion, inhalation and skin absorption, then they slowly accumulate in the body tissues: kidneys, liver, pancreas, bones, central nervous system, causing so many health implications like cancer, autoimmunity etc. Therefore,

- Research should be done to know the effect of different cooking methods on heavy metal in rice and generally, in food.
- Research should be conducted with cooked rice, to know the concentration of heavy metals in cooked rice (which is the consumable form of rice)
- Programs should be organized in urban and rural areas to enlighten individuals on the dangers of environmental pollution caused by heavy metals.
- More research should be conducted on heavy metals in different food consumed in Nigeria.
- It is necessary to know the effects of processing of rice, on heavy metals in rice.
- Finally, research should be done to discover what can be used or technologies that can render heavy metals in soils non-hazardous.

Conflict of Interest

The authors declare that there is no conflict of interest.

Bibliography

1. Imolehin ED and Wada AC. "Meeting the Rice Production and Consumption demand of Nigeria with improved Technologies". National Cereal Research Institute, Badeggi, PMB 8, Niger State, Nigeria (2000): 1-11.
2. Saka JO and Lawal BO. "Determinants of adoption and productivity of improved rice varieties in south western Nigeria". *African Journal of Biotechnology* 8.19 (2009): 4923-4932.
3. Loan S., *et al*. "Analysis of heavy metal pollution and pattern in central Transylvania". *International Journal of Molecular Science* 9 (2008): 434-453.
4. Duruibe JO., *et al*. "Heavy metal pollution and human biotoxiceffects". *International Journal of Physical Science* 2.5 (2007): 112-118.
5. Jarup L. "Hazards of heavy metal contamination". *British Medical Bulletin* 68 (2003): 167-182.
6. Otitoju O., *et al*. "Heavy metal contamination of green leafy vegetable garden in Itam road construction site in Uyo, Nigeria". *Research Journal of Environmental and Earth Sciences* 4.4 (2012): 371-375.
7. McLaughing MJ and Singh BR. "Cadmium in soil and plants: a global perspective. Cadmium in soils and plants". The Netherland: Kluwer Academic Publishing (1999).
8. Reeves PG and Chaney RL. "Mineral Nutrients status of female rats affects the absorption and organ distribution of cadmium from sunflower kernels (Helianthus annuus L.)". *Journal of Environmental Resources* 85 (2001): 215-225.
9. Hezbullah M., *et al*. "Heavy metal contamination of food in a developing country like Bangladesh: An Emerging threat to food safety". *Journal of Toxicology and Environmental Health Science* 8.1 (2016).
10. Tuzen M. "Determination of heavy metals in fish samples of the middle Black Sea (Turkey) by graphite furnace atomic absorption spectrometry". *Food Chemistry* 80 (2003): 119-123.
11. Yargholi B and Azim AA. "Investigation of Cadmium absorption and accumulation in different parts of some vegetables". *American Eurasian Journal of Agriculture and Environmental Science* 3 (2008): 357-364.
12. Reynders H., *et al*. "Accumulation and effects of metals in caged carp and resident roach along a metal pollution gradient". *Science Total Environment* 391 (2008): 82-95.
13. Mapanda F., *et al*. "The effect of longterm irrigation using wastewater on heavy metal contents of soils under vegetables in Harare, Zimbabwe". *Agriculture Ecosystem and Environment* 107 (2005): 151-165.
14. UNEP/FAO/WHO. "Assessment of dietary intake of chemical contaminants". Nairobi: United Nations Environmental Program (1992).
15. CONTAM. "Scientific Opinion on Lead in Food". EFSA Panel on Contaminants in the Food Chain (CONTAM). *EFSA Journal* 8.4 (2010): 1573.
16. Cheng F., *et al*. "Cadmium and lead contamination in Japonica rice grains and its variation among the different locations in southeast China". *Science Total Environment* 359 (2006): 156-166.

17. Liu WX., *et al*. "Heavy metal accumulation of edible vegetables, cultivated in agricultural soil in the surburb of Zhengzhou city, China". *Bulletin of Environmental Contamination and Toxicology* 76 (2006): 163-170.

18. WHO, World Health Organization. "Evaluation of certain food additives and contaminants". (41st report of the joint FAO/ WHO expert committee on food additives). WHO Technology (1993).

Volume 3 Issue 2 February 2019