Science World Journal Vol. 18(No 3) 2023
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University
DOI: https://dx.doi.org/10.4314/swj.v18i3.5

Full Length Research Article

INVESTIGATION OF HEAVY METALS CONTAMINANTION LEVEL IN THE LOCALLY CULTIVATED RICE USING ATOMIC ABSORPTION SPECTROSCOPY (AAS)

Lawan Musa Yalwa, *Sani Garba Durumin-Iya, Abdulhamid Mikail Abdulhamid, Muhammad Uzair, Suleiman Bashir Adamu and Ibrahim Garba Shitu

Department of Physics, Faculty of Natural and Applied Sciences, Sule Lamido University Kafin Hausa, 048 Kafin Hausa, Jigawa State, Nigeria

*Corresponding Author Email Address: sanig.duruminiya@slu.edu.ng

ABSTRACT:
Rice (Oryza sativa) is a stable food in many countries in the world including Africa. The present of heavy metals in the environment which are toxics affect the nutritional value of the rice. The accumulation of heavy metals in the body may lead to different health problems such as cancer, diabetes, liver and kidney failure. The study was conducted to access the presence of some selected heavy metals (Pb, Cu, Cd, As, Ni, Zn) in rice sample using atomic absorption spectroscopy technique. Five sample of rice (EX-CHINA, CP, WHEETER-4, ROBBER, and YERMALINTA) which were cultivated in Damashewa village of Kirikasamma local government area were collected. Wet digestion method was used to destroy organic matter in the sample. The result of analysis showed that the concentration of Zinc(Zn) in all the four sample of rice range from (16.50-36.02mg/kg) and that of Cadmium Cd (0.05-0.18mg/kg) and that of copper Cu (7.02-22.20mg/kg) which is far below the safety limit of 50-100mg/kg for zinc and 0.4mg/kg for cadmium, and copper is 73.3mg/kg set up by the FAO/WHO (2001), this could lead to anaemia, renal damage, bones disorder and cancer of the lungs. While the concentration of lead Pb (3.57-16.24mg/kg), nickel Ni (2.50-11.24mg/kg) and that of Arsenic As (0.98-4.33mg/kg) is also above the set safety limit of 0.3mg/kg for lead. Based on this research all rice sample were highly contaminated with lead, arsenic and nickel as a pollutant. Thus, the need for physical examination of the consumers and inhabitants within the study area.

Keywords: Rice (Oryza sativa), Atomic absorption spectroscopy (AAS), Exchina, whieeter-4, Robber, CP, Yermalinta, FAO/WHO

INTRODUCTION

The discharge of effluents from industry in to agricultural compartment has become a growing environmental problem. Long term land application of effluents water (EW) may cause excessive accumulation of heavy metals such as Cadmium (Cd), Lead (Pb), Zinc (Zn) and Arsenic (As) in soil and toxicity in plants [1]. Heavy metals like Iron ,Copper, Zinc and Nickel and other trace elements are important for proper functioning of biological systems and their deficiency or excess could lead to a number of disorder [2].
Rice (*Oryza sativa)* is stable food in many countries of Africa and other part of the world. It is the most important stable food for about half of human race [3]. Heavy metals can enter in to food chain from aquatic and agricultural ecosystems and threaten human health [4]. People, especially those who take rice as main food for daily energy are exposed to significant amount of heavy metals via rice [5].
Industrial effluents enter the adjacent water body (river, lake, dams) through an inland water way. During the rainy season, the EW directly flows over the agricultural field. Local farmers frequently use water from this source (river, lake, dams) for irrigation purpose. According to [6]. depositions of some heavy metals are elevated in water, sediment and agricultural soil of this area.
Nowadays, water quality issues are gaining recognition as river waters are getting heavily polluted at many places. Moreover, groundwater quality, at many places, is beginning to deteriorate to cause serious implications on the supply of water for drinking, irrigation and industrial use as all of them are important determinants of public health. The level of natural contaminants and chemical pollutants is high and also is increasing at several places. Environmental pollution became all the more hazardous as the urban life became more and more prevalent. Rather, it has increased parallel to the industrial development. In the second half of twentieth century, increasing environmental pollution due to rapid industrialization and population growth has caused natural resources to become more polluted so that destruction of ecosystem became an acute issue. The effluents discharged from the industries into the water bodies contain many toxic compounds like phenols, oils, pesticides, heavy metals, xenobiotics and polyaromatic hydrocarbons. These effluents affect the physicochemical parameters of water such as temperature, pH, dissolved oxygen, total solids, dissolved solids and suspended solids. These parameters are often employed to assess the water quality [15].
In addition, the heavy metals form the core group of pollutants in the industrial and daily life activities. The exceeding contents of heavy metals like Cr, Mn, Fe, Co, Ni, Cu, Zn, Cd and Pb were also reported in several freshwater resources so that the available water has been rendered unsafe for domestic consumption, irrigation, and industrial needs. In a nutshell, this degradation of water quality has led to water scarcity for the human consumption [16].
The poisoning effects of heavy metals are due to their interference with the normal body biochemistry in the normal metabolic processes. When ingested, in the acid medium of the stomach, they are converted to their stable oxidation state (Cd^{2+}, Pb^{2+}, Hg2+, and As2+) and combined with body's biomolecules such as protein and enzymes to form strong and stable chemical bound. Cadmium poisoning in man could lead to anemia, renal damage, bones disorder and cancer of the lungs [11].

METHODOLOGY

Rice was collected from local farmers in Damashewa village of Kirikasamma Local Government, Jigawa state, Nigeria. All sample

Science World Journal Vol. 18(No 3) 2023
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University
DOI: https://dx.doi.org/10.4314/swj.v18i3.5

were kept in clean polyethylene bags and brought to the laboratory for analysis. Rice samples were washed with deionized water and hulls were removed. The rice samples without hulls were oven-dried at 70 °C for 24hrs and then grinded with an agate mortar to fine powder. One (1g) of ground dried rice sample was placed in a small beaker. 10 mL of concentrated HNO_3 was added to it and it was allowed to stand overnight. The beaker was cooled and small amount of 4 mL of 70% $HClO_4$ was added to the mixture. The mixture was heated again and allowed to evaporate to a small volume. The final suspended mixture was filtered through 2.5-mm standard quantitative cellulose filter paper and the sample was transferred to a 50-mL flask and diluted to volume with distilled water. Statistical Package for the Social Sciences (SPSS) was used for the statistical analysis. Data obtained from the experiment were subjected to one- way analysis of variance (ANOVA). Statistical significant different was set at 2%, the comparison of the mean was perfumed using Duncan method. One sample t-test was applied to compare the mean values of each element with the available standard of (P<0.05).

RESULT AND DISCUSSION

The average mean concentrations of heavy metals in the locally cultivated rice in the study area (Damashewa village in Kirikasamma local government Area) using Atomic absorption spectroscopy machine (AAS) are shown in table 1. The results are expressed as mean ± S.D.

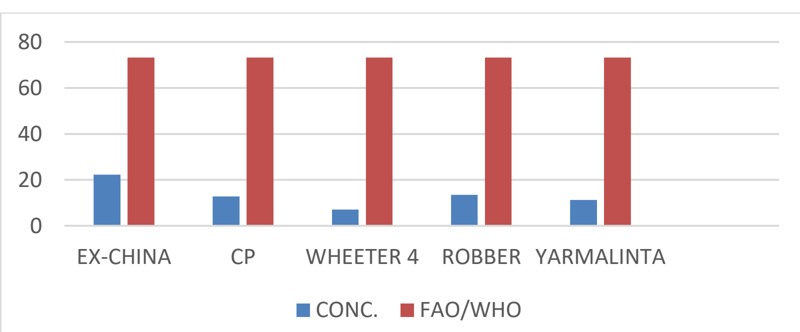
Table1: Average concentration of heavy metals in rice the values are expressed as Mean ± SD (n=3).

METALS	EX-CHINA (mg/kg)	CP (mg/kg)	WHEETER-4 (mg/kg)	ROBBER (mg/kg)	YARMALINTA (mg/kg)	SAFE LIMIT (mg/kg)
Cu	22.20±0.36	12.80±0.01	7.02±0.10	13.50±0.23	11.25±0.34	73.3
As	1.05±0.60	4.33±0.00	2.01±0.13	0.98±0.02	1.57±0.06	0.2
Cd	0.17±0.02	0.09±0.00	0.18±0.07	0.15±0.03	0.05±0.03	0.4
Ni	7.03±0.01	2.50±0.06	5.92±0.04	11.24±0.10	8.40±0.51	0.1
Pb	8.40±0.14	3.40±0.37	11.02±0.11	17.13±0.21	7.90±0.05	0.3
Zn	36.02±0.27	16.50±1.05	8.37±0..73	26.06±0.21	19.23±0.7	50-100

From Table 1, the average mean concentration of the Zinc (Zn) in all four sample of rice range from (16.50-36.02mg/kg) which is far below the safety limit of 50-100mg/kg. The average mean concentration of Cadmium Cd is (0.05-0.18mg/kg), for copper Cu is given as (7.02-22.20mg/kg).

Similarly, the average mean concentration mg/kg set up by the FAO/WHO (2001) is 0.4mg/kg for cadmium, and copper is 73.3mg/kg, this could be account from the non- contamination of the rice during agronomics practice such as cultivation, processing, storage, pesticide, and fertilizer application, while the mean concentration of lead Pb is (3.40-17.13mg/kg), nickel Ni (2.50-11.24mg/kg) and that of Arsenic As (0.98-4.33mg/kg) which are above the standard safety limit of 0.3mg/kg for lead, Nickel 0.1 mg/kg and Arsenic 0.2 mg/kg respectively. This trend could be attributed to the contamination of rice due to anthropogenic activities such as (mining and smelting) and agronomics activities such as fertilizer, pesticides, Bio-solids, and manure application, wastes water or metal mining and industrial wastes.

The graphical representations of these contaminations for all the five rice samples are presented in Figure 1,2,3,4, 5 and 6 respectively.



Science World Journal Vol. 18(No 3) 2023 DOI: https://dx.doi.org/10.4314/swj.v18i3.5
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

Figure 1: Comparison of Concentration of copper Cu in rice with FAO/WHO

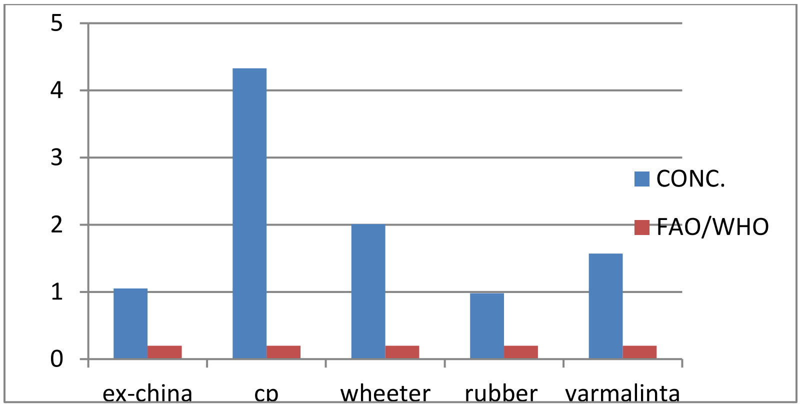


Figure 2: Comparison of Concentration of Arsenic As in rice with FAO/WHO

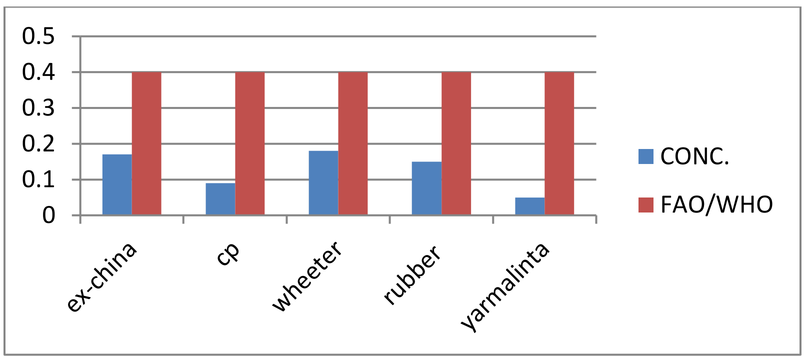


Figure 3: Comparison of Concentration of Cadmium in rice with FAO/WHO

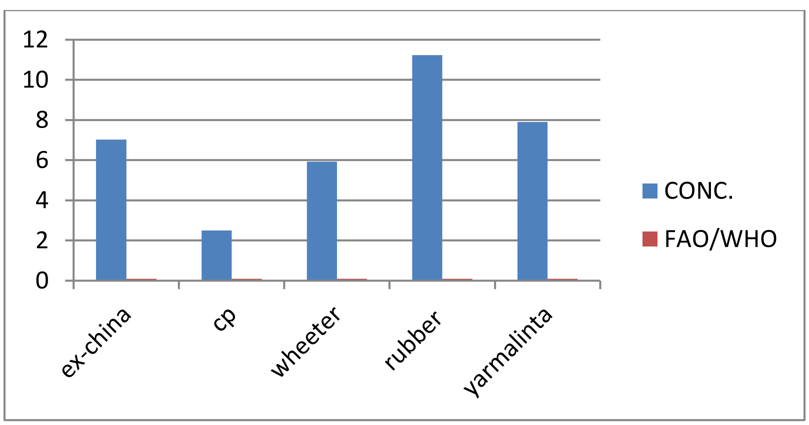


Figure 4: Comparison of Concentration of Nickel in rice with FAO/WHO

DOI: https://dx.doi.org/10.4314/swj.v18i3.5

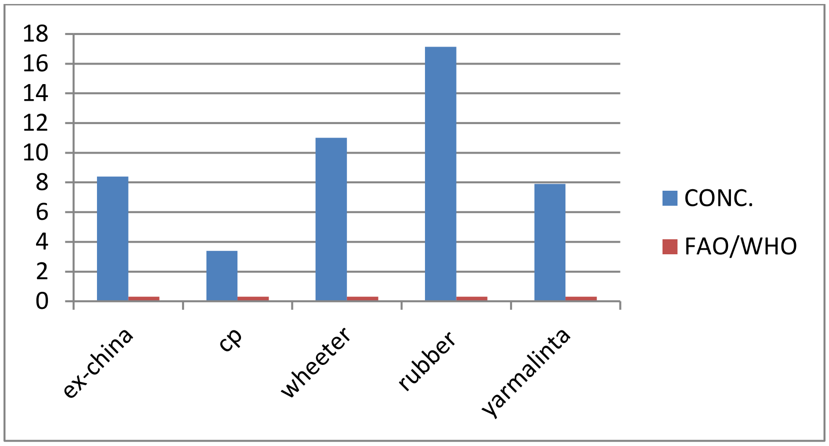


Figure 5: Comparison of Concentration of Lead in rice with FAO/WHO

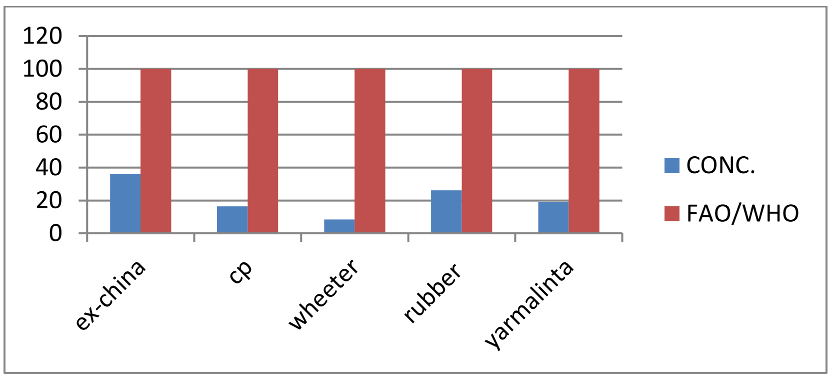


Figure 6: Comparison of Concentration of Zinc in rice with FAO/WHO

According to (FAO/WHO, 2001), some heavy metals (like Fe, Zn, Ni) have been reported to be of bio-importance to man and their daily medicinal and dietary allowance had been recommended. Their tolerance limit in food, drinking and portable water have also been reported. However, some others (like As, Cd, Pb, and Methylated form of mercury) have been reported to have no known bio-importance in human biochemistry and physiology and consumption even at very low concentration can be toxic [7]. Even for those that have bio-importance, dietary intakes have to be maintained at regulatory limit, as excess would result in poisoning or toxicity, which is evident by certain reported medical symptoms that are clinically diagnosable [8]. Humans are in turn exposed to heavy metals by consuming contaminated plants and animals, and this has been known to result in various biochemical disorders, in summary all organisms within a giving ecosystem are variously contaminated along their cycle of food chain.
As can be seen from table 1, the levels of zinc were 3.57mg/kg. The content of zinc reported in this study is generally lower than the permissible level set by FAO/WHO of 50-100mg/kg .Zinc is essential to all organisms and has an important role in metabolism, growth, development and general well-being. It is an essential co-factor for a large number of enzymes in the body. Zinc deficiencies lead to coronary heart diseases and various metabolic disorders [9]. Deficiencies of zinc can also result from inadequate dietary intake, impaired absorption, excessive excretion or inherited defect in zinc metabolism [10].

The level of copper Cu and cadmium in all four varieties of rice are below permissible limit. Copper Cu Is one of the essential micronutrients and its adequate supply for growing plant should be ensured through artificial or organic fertilizer. Copper (Cu) occur in the compounds with no known function as well as enzymes having vital function in plant metabolisms [11]. Cadmium is highly toxic non-essential heavy metal and it does not have a role in biological process in living organisms. Thus even is low concentration / cadmium could be harmful to living organisms [12].
Result obtained shows that, the level of the lead in the rice were above the permissible limit. The content of lead in this research was 3.57mg/kg which is above the safety limit of 0.3mg/kg. Lead toxicity is known to cause muscolo-skeletal, renal, ocular, neurological, immunological, reproductive and developmental effects [12].
Cadmium was not detected in the rice. Cadmium is highly toxic non-essential heavy metal and it does not have a role in biological process in living organism [13]. Thus, even in low bioaccumulation of cadmium could be harmful to living organism [12]. Cadmium poisoning in man could lead to anemia, renal damage, born disorder, and cancer of the lungs [14].
The aim of this research is to determine the level of heavy metal contamination which is the first step in making efforts in mitigation. The findings of this research revealed that, there is presence of heavy metals contamination in the locally cultivated rice consumed within the study area. Hence, the goal was achieved and this may

DOI: https://dx.doi.org/10.4314/swj.v18i3.5

necessitate the action by the responsible agency in tackling the aforementioned contamination.

Conclusion
Heavy metals occur naturally in ecosystem, but rarely at toxics levels. They are persistent environmental contaminant since they cannot be easily degraded or destroyed. The study assessed heavy metals level in locally cultivated rice in Kirikasamma local government area. The concentration of six heavy metals (Pb, Cd, Cu, Ni, As and Zn) in five varieties of rice (EX-CHINA, CP, WHEETER, ROBBER and YARMALINTA), collected from local farmers in Hadejia were determined using atomic absorption spectroscopy. Wet digestion method was used to destroy the organic matter to determine the content of four heavy metals. The result showed that the concentration of lead range from (3.40-17.13mg/kg) , Cu (7.02-22.20mg/kg), Cd (0.05-0.18mg/kg), Zn (16.50-36.02mg/kg), Ni (2.50-11.24mg/kg) and that of Arsenic As (0.98-4.33mg/kg) in these results the concentration of Pb, Ni and As in all samples was found to be higher than that of FAO/WHO recommended limit in rice. While for Cd, Cu and Zn measured in all samples of the rice were below the permissible limit of FAO/WHO., hence the consumption of these rice samples contaminated with heavy metals may results in its accumulation in the body leading to different health problems such as cancer, diabetes, liver and kidney failure. As reported by the General Hospital within the research area, there is prevalent cases of cancer, diabetes, liver and kidney failure, thus it is significant to note that, the cases, may be attributed to the consumption of heavy metals.

REFERENCES
1) Hamid, R.R, Hossain S.M, Latif S.A, and Uddin M.M .(2007). Assessment of heavy metals in Dept effluent discharge area by Neutron Activation analysis. *Journal nagger physics studies***. 1**(4):37-46.
2) Alam, K, Lui, J, Selim, and Zhao, K.H. (2003). Heavy metals contamination in a soil-rice system: Identification of spatial dependence in relation to soil properties of paddy fields. *Journal of Hazard material* 18(4):778-787.
3) Chaney, L.E., Himry, J.I. (2000). Biomedical implications of heavy metals induce imbalances in redox remediation systems. *Bio-medical Research International.***9**(8): 640 - 754.
4) ZozoLi, M.A, Shokuzadeh, M, Bazeraf, Shane, Harzrati, M, and Tavak-kouti, A. (2006).investigation of Zinc content in Iranian rice (Oryza Sativa) and its Weekly intake*. American-Eurasian Journal of Agricultural and Environmental Science*; **1**(2):59APPENDIX
5) Watanabe, T, Shimjbo, S, Moon, C.S, Thangzw, V, and Ikeda M.(2016) Cadmium contents in rice samples various area in the world. *Science of the total environment Journal* **18**:96-191.
6) Jarup, L.E (2003). Analysis of transgenic Indian mustard plants for phytoremediation of metal contaminated mine tailing*. Journal ofenvironmental quality***3**(2):432-440.
7) Holum, J.R, Sons, S, and John, W. (2002). Elements of General and Biological Chemistry, 6th Edition, John Wiley and Sons, N.Y. Pp. 324, 326, 353, 469.
8) Nolan, K, Fosmire, G.J. (2003). Copper Toxicity Syndrome, *Journal*. *Orthomol. Psychiatry***12**(4):
9) Saraf, A, Samant, A.F.(2013). Evaluation of some minerals and trace elements in Achyranthesaspera linn. *International Journal of Farmer Science.***3**(3): 229-233.
10) Ozturk, E, Atsan, E, Polat, T, and Kara, K. (2011).Variation in heavy metals concentration of a paw-paw from a Kaani, Bori, river state Nigeria. *International ResearchJournal.* Public Environ. Heaithpotato(solanum tuberosum L.) cultivars. *Journal Animal and Plant Science.* **21**(2); 235-239
11) Ellen, C, Rengel, Z, and Sahu, S.K. (2013). *Heavy metals as essential nutrient* in: prasad MNV (ed). Heavy metals stress in plants, 3rd edition. Springer, Berlin, Pp. 271-294.
12) Ambedkar, G, Munyan, M (2012). Analysis of heavy metals in water, sediment and selected rivers *Journal of environmental pollution.***1**(4): 87-94
13) Isiyaku, Aliyu Kabiru, and S. B. Ghoshal. "Photoluminescence spectral features of silicon nanowires." J. Teknol 2.78 (2016): 153-158.
14) AbdulKadir, S., Ishaq, S., Auta, K. I., Ibrahim, B., & Isiyaku, A. K. (2023). Household Plastic Waste Generation and Composition in Selected Locations Within Kaduna Metropolis. International Journal of Emerging Multidisciplinaries: Biomedical and Clinical Research, 1(1).
15) Javed, M., & Usmani, N. (2019). An overview of the adverse effects of heavy metal contamination on fish health. *Proceedings of the National Academy of Sciences, India Section B: Biological Sciences*, *89*, 389-403.
16) Yalwa, L. M., Durumin-Iya, S. G., & Ahmad, H (2023). Assessment of Heavy Metals in Fish Tissues of Tilapia and Catfish from River Hadejia, Northern Nigeria, 3, 2, 11-14.