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Evaluation of Heavy Metals in Iranian and Non-Iranian Rice Supplied by Shopping Centers of Kashan, Iran

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Authors
Rabbani D.[1] *PhD,*
Mostafaii Gh.R.[2] *PhD,*
Dehghani R.[1] *PhD,*
Gilasi H.[3] *PhD,*
Hosein Abadi Z.* *MSc*

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*Environmental Health Engineering Department, Health Faculty, Kashan University of Medical Sciences, Kashan, Iran
[1]"Environmental Health Engineering Department, Health Faculty" and "Social Determinants of Health Research Center", Kashan University of Medical Sciences, Kashan, Iran
[2]Environmental Health Engineering Department, Health School, Kashan University of Medical Sciences, Kashan, Iran
[3]Environmental Health Department, Health Faculty, Kashan University of Medical Sciences, Kashan, Iran

Correspondence
Address: Sadra 11 street, Zibashahr, Zahedan, Iran. Postal Code: 9817915881
Phone: +985433284044
Fax: +983155540111
hbkashan@yahoo.com

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ABSTRACT

Aims Heavy metals in the environment are toxic to plants, animals and human. This study aimed to investigate concentration of Arsenic, Lead and Cadmium in Iranian and non-Iranian rice which have been sold in Kashan City, Iran shops.
Materials & Methods In this cross-sectional study, 126 samples from 42 trademarks (15 Iranian and 27 non-Iranian) rice were collected from Kashan shopping centers. At first each sample was ashed, and then they have been dissolved with nitric acid. Heavy metal concentration was evaluated by inductively coupled plasma emission spectrophotometer. Data were analyzed by SPSS 16 software using One-sample and Independent T-tests.
Findings Arsenic was not found in any of rice samples. There was a significant difference between Pb concentration in both Iranian and non-Iranian rice samples.
There was not a significance difference between Cd concentration in Iranian ($p=0.823$) and non-Iranian ($p=0.346$) rice samples according to Iran national standards but there was a significant difference between Cd concentration in both Iranian ($p=0.001$) and non-Iranian ($p=0.001$) rice samples according to WHO and FAO standards.
Conclusion Consumed rice pollution with Pb is considerable but with Cd is low. Arsenic concentration in Iranian and non-Iranian rice is less than Iran national and WHO/FAO standards.

Keywords Metals, Heavy; Cadmium; Lead; Arsenic

CITATION LINKS

[1] Distribution of pesticides, PAHs and ... [2] Risk assessment of heavy metals in ... [3] Heavy metals in rice and ... [4] High levels of heavy metals in rice (Oryza sativa L.) from a typical E-waste recycling area in southeast China and its potential risk to human ... [5] Lead enrichment in different genotypes of ... [6] Seasonal variations in heavy metal concentration in ... [7] Lead toxicity, uptake, and translocation in different rice ... [8] Arsenic round the ... [9] Atmospheric concentrations and dry deposition fluxes of particulate trace metals in Salvador, Bahia ... [10] Heavy metal-regulated new microRNAs from ... [11] Arsenic in the environment: Effects on ... [12] Risks of herbicide-resistant rice in ... [13] Investigation of metals accumulation in some vegetables irrigated with waste water in ... [14] Lead, cadmium and nickel in chocolates and ... [15] Heavy metal contamination of ... [16] Heavy metal contamination of soil and ... [17] Distribution of organochlorine pesticides and ... [18] Health risk assessment of heavy metals via dietary intake of foodstuffs from the wastewater irrigated site of a dry tropical area of ... [19] Assessment of heavy metal contamination in ... [20] Assessment of heavy metal contents in the ... [21] Health risk from heavy metals via consumption of ... [22] Cobalt and nickel uptake by rice and accumulation in soil amended with municipal solid waste ... [23] Heavy metal transfer from composted macroalgae to ... [24] Variations in heavy metal accumulation, growth and ... [25] The influence of pH and organic matter content in ... [26] Heavy metals in wild rice from ... [27] Food & feed-maximum limit of ... [28] Determination of ... [29] Investigation of Cadmium and Lead contents in Iranian rice cultivated in Babol ... [30] Cadmium and Lead contents in rice (Oryza sativa) in the north of ... [31] Assessment of Hematotoxic effects of occupational exposure to unleaded ... [32] Determination and estimation of ... [33] Evaluation of Lead, cadmium and Copper in black tea leaves in Mazandaran factories, spring and ...

All keywords and available citations are linked in this page.

Introduction

Heavy metals in the environment are toxic to plants, animals and human [1]. For example, acute exposure to cadmium (Cd) leads to itai-itai disease [2]. The adverse health effects of Cd exposure may cause kidney and bones damages [3, 4]. Lead (Pb) is a non-essential and toxic element for metabolic process [5]. It has been demonstrated that exposure to Pb can lead to amnesia, encephalitis, constipation and death [6]. Pb is able to replace calcium in bones, hurt red blood cells and genital organs [7]. It has been stated that low intake of arsenic (As) causes cancer [8]. Some diseases such as black foot disease, hypertension, diabetes, cancroids, lung, kidney and liver cancer can appear due to Arsenic [9].

Rice as an herbal plant contains protein and is ranked as the second high consumed cereal in the world. Half of the world populations consume rice as their main food [10]. Contaminated rice may result in heavy metals intake, so the quality of rice can affect human health [11]. About half of the rice is cultivated in Asia worldwide [12]. Several previous studies in Iran and India reported heavy metals in wastewater [13], chocolates [14], rivers [15], vegetables [16], fishes and oysters [17], soils [18, 19], and the ambient air [20]. So, it is necessary to consider information about heavy metals concentration in agricultural products and daily intake of each one to assess and monitor human health [21].

Heavy metals can enter plants by different ways such as utilization of wastewater for irrigation [22], macro algae [23], using sludge [24], and pesticides and industrial wastewater [25]. Using abandoned landfill sites as agricultural lands that potentially may be contaminated by heavy metals including Pb, Cd and As can lead to agricultural products contamination [6]. Heavy metals can be absorbed by plants cultivated in the polluted fields [6]. So soil-crop foods are the main way for heavy metals exposure [4]. Industrial processes, fossil fuel combustion, burning of wood and solid wastes are the major anthropogenic path of heavy metals emission to the atmosphere; as a result, natural and manmade sources of heavy metals emission to the atmosphere are raised increasingly [9]. Heavy metals can be absorbed by rice through the atmosphere [26].

Due to the adverse effects of heavy metals on humans' health and importance of rice as a main food in Iran, the present study aimed to investigate the presence of heavy metals such as Pb, As, and Cd in rice samples including Iranian and non-Iranian, presented in Kashan, Iran shops in 2013.

Materials & Methods

In this cross-sectional study, 126 samples from 42 trademarks (15 Iranian and 27 non-Iranian) rice were collected from Kashan shopping centers during December to February 2013.

First, each sample was grinded and mixed entirely, and 5g of the sample was heated at 110-20°C, for 2h. The dried sample was heated in the oven at 450°C. The residue ash was moved to 25ml balloon, and 3ml nitric acid was added to dissolve the ash. The balloon content was diluted by deionized water. Finally, the heavy metal concentration was evaluated by inductively coupled plasma emission spectrophotometer [24]. The minimum detection accuracy was 0.042, 0.027 and 0.053mg/L for Pb, Cd, and As, respectively.

To evaluate the potential risk of rice consumption containing the heavy metals, Provisional Tolerable Daily Intake (PTDI) for a 60kg adult person was calculated by the following equation in which C is the heavy metal concentration in rice, Cons is the average consumption of rice in country (110g per capita per day) and BW is body weight of an Iranian adult person (60kg). The output was compared with the WHO/FAO and Iranian standard level.

$$\mathrm{PTDI} = \frac{\mathrm{C} \times \mathrm{Cons}}{\mathrm{Bw}}$$

The Iran standard PTDI limits have been recommended for, Cd, Pb and As 0.001, 0.0036 and 0.0021mg/day/kg Bw, respectively [27].

Data were analyzed by SPSS 16 software using One Sample T-test for comparison of heavy metal concentration in rice samples and standard values. Also, Independent T-test was employed for comparison of heavy metal concentrations in Iranian and non–Iranian rice.

Findings

Arsenic was not found in any of rice samples.

The average concentration of Pb in 45 samples of 15 Iranian and 81 samples of 27 non-Iranian trademarks was 0.6416±0.3055mg/kg and 0.8088±1.0796mg/kg, respectively. According to Iran national standards, there was a significant difference between Pb concentration in both Iranian (p=0.0001) and non-Iranian (p=0.005) rice samples. According to WHO and FAO standards, there was also a significant difference between Pb concentration in both Iranian (p=0.004) and non-Iranian (p=0.028) rice samples. By comparison of daily intake of Pb by Iranian (0.0035mg/kg; p=0.872) and non-Iranian (0.004mg/kg; p=0.464) rice consumption; there was not a significance difference between PTDI of these two types of rice by Iran national standard level (p>0.05).

The average concentration of Cd in 45 samples of 15 Iranian and 81 samples of 27 non-Iranian trademarks was 0.0636±0.0539 and 0.0463±0.06864mg/kg, respectively. According to Iran national standards, there was not a significance difference between Cd concentration in Iranian (p=0.823) and non-Iranian (p=0.346) rice samples but according to WHO and FAO standards, there was a significant difference between Cd concentration in both Iranian (p=0.001) and non-Iranian (p=0.001) rice samples.

According to Iran Standard Organization, lead contamination in Iranian and non-Iranian rice was 100 and 96.3%, respectively, while based on the WHO standard it was 100 and 74%, respectively. Cadmium concentration was higher than Iranian standard level in 33.3% of Iranian and 18.5% of non-Iranian rice samples. Based on WHO standard level 6.7% of Iranian and 3.7% of non-Iranian rice samples were contaminated by Cd.

Discussion

Arsenic and arsenic compounds are carcinogenic and lead to infants with low birth weight [11]. In the present study, the concentration of As in samples was less than the minimum Inductively Coupled Plasma (ICP) accuracy (0.053mg/L).

The Iran Standard (No. 12968) has set Pb intake limit of 0.15mg/kg and WHO/FAO assigned permissible Pb intake limit of 0.3mg/kg [28]. Pb concentration in %100 of Iranian and %96.3 of non-Iranian rice was higher than Iranian standard. One Sample T-test has confirmed a significant difference for Pb concentration in Iranian and non-Iranian rice than the standard.

A previous study reveals that concentration of Pb in Indians rice (0.364mg/kg) is higher than permissible limits of WHO/FAO and Iran national standards [28]. This difference could be related to ICP accuracy in this study because ICP method has more accuracy and precision than atomic absorption [29]. Zazouli *et al*. found that Pb concentration in Iranian rice from Iran north farms was 11.5mg/kg which had been more than this study [29]. Khaniki & Zazoli have reported that Pb concentration of rice cultivated in Iran North farms was 2.23mg/kg that was higher than permissible limits of WHO/FAO and Iranian standard [30]. The Pb diminution in the Iranian rice mostly can be related to the discontinuity of Pb compounds utilization in gasoline after 2001 [31]. Another study by Fu *et al.* has reported that Pb concentration in the soil of an electronic waste cycling site in China was 0.69mg/kg [4]. Min *et al.*, has stated that Pb concentration in the rice cultivated on polluted industrial lands of Jiangsu city had been measured 0.054mg/kg, which is less than that of this study [3]. Degree of industrialization, distance between farms and pollution sources such as cement, steel and iron mills, also fertilizers type are the main factors for different results. Assuming a 60kg weight person, and 110g daily rice consumption, the daily intake of Pb by Iranian rice was calculated 0.0035mg/day/kg bw which is less than Pb intake limitation in Iran (0.0036mg/day/kg bw). In the case of non-Iranian rice it was 0.004mg/day/kg bw that is more than verified PTDI in Iran.

The danger due to Cd is critical even in low concentration [24]. Iran Standard (No. 12968) has established the maximum limit of Cd in rice about 0.06mg/kg [27]. No significant difference was observed between Cd concentration in Iranian/non-Iranian rice and Iran standard. The Cd concentration was higher than Iran standard in 33.3% and 18.5% of Iranian and non-Iranian rice respectively. The concentration of Cd in Tarom (an Iranian brand) rice, has been reported 0.41mg/kg which was higher than both Iran and FAO standards (permissible limit 0.06, and 0.2mg/kg) [32]. In the mentioned study by Men *et al.*, the concentration of Cd has been reported 0.2mg/kg [3]. Different factors such as soil, atmosphere, etc. can affect the elements inventory of plants. So, the different results in the mentioned studies may be due to these factors [33]. PTDI of Cd was calculated based on assumptions for Pb, therefore the PTDI was 0.00035 and 0.00025mg/day/kg bw for Iranian and non-Iranian rice respectively. These findings are far less than 0.001mg/day/kg bw as its goal in Iran standard.

The Iran standard PTDI limits have been recommended for, Cd, Pb and As 0.001, 0.0036 and 0.0021mg/day/kg bw, respectively that were of limitation of this study. Nowadays, concerns about feeding by polluted agricultural products (especially by heavy metals) have been increased. So, it is crucial to manage and control heavy metals concentration in these kinds of products.

Conclusion

Arsenic concentration in Iranian and non-Iranian rice is less than Iran national and WHO/FAO standards. Pb concentration in 100% Iranian and 96.3% non-Iranian rice is higher than Iran national standard and in 100% of Iranian and 74% of non-Iranian rice is higher than WHO/FAO standards. Cd concentration in 33.3% of Iranian and 18.5% of non-Iranian rice is higher than Iran national standard and in 6.7% of Iranian and 3.7% of non-Iranian rice is higher than WHO/FAO standards.

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References

1- Amaraneni SR. Distribution of pesticides, PAHs and heavy metals in prawn ponds near Kolleru lake wetland, India. Environ Int. 2006;32(3):294-302.

2- Li P, Wang X, Allinson G, Li X, Xiong X. Risk assessment of heavy metals in soil previously irrigated with industrial wastewater in Shenyang, China. J Hazard Mater. 2009;161(1):516-21.

3- Cao H, Chen J, Zhang J, Zhang H, Qiao L, Men Y. Heavy metals in rice and garden vegetables and their potential health risks to inhabitants in the vicinity of an industrial zone in Jiangsu, China. J Environ Sci. 2010;22(11):1792-9.

4- Fu J, Zhou Q, Liu J, Liu W, Wang T, Zhang Q, et al. High levels of heavy metals in rice (Oryza sativa L.) from a typical E-waste recycling area in southeast China and its potential risk to human health. Chemosphere. 2008;71(7):1269-75.

5- Chen G, Sun GR, Liu AP, Zhou WD. Lead enrichment in different genotypes of rice grains. Food Chem Toxicol. 2008;46(3):1152-6.

6- Oluyemi EA, Feuyit G, Oyekunle JAO, Ogunfowokan AO. Seasonal variations in heavy metal concentration in soil and some selected crops at a landfill in Nigeria. Afr J Environ Sci Tech. 2008;2(5):89-96.

7- Liu J, Li K, Xu J, Zhang Z, Ma T, Lu, X. Lead toxicity, uptake, and translocation in different rice cultivars. Plant Sci. 2003;165(4):793-802.

8- Mandal BK, Suzuki KT. Arsenic round the world: A review. Talanta. 2002;58(1):201-35.

9- de P, Pereira PA, et al. Atmospheric concentrations and dry deposition fluxes of particulate trace metals in Salvador, Bahia, Brazil. Atmospher Environ. 2007;41(36):7837-50.

10- Huang SQ, Peng J, Qiu CX, Yang ZM. Heavy metal-regulated new microRNAs from rice. J Inorg Biochem. 2009;103(2):282-7.

11- Singh N, Kumar D, Sahu AP. Arsenic in the environment: Effects on human health and possible prevention. J Environ Biol. 2007;28(2 Suppl):359-65.

12- Kumar V, Bellinder RR, Brainard DC, Malik RK, Gupta RK. Risks of herbicide-resistant rice in India: A review. Crop Protect. 2008;27(3):320-9.

13- Bigdeli M, Seilsepour M. Investigation of metals accumulation in some vegetables irrigated with waste water in Shahre Rey-Iran and toxicological implications. Am Eur J Agric Environ Sci. 2008;4(1):86-92.

14- Dahiya S, Karpe R, Hegde AG, Sharma RM. Lead, cadmium and nickel in chocolates and candies from suburban areas of Mumbai, India. J Food Compos Anal. 2005;18(6):517-22.

15- Kaushik A, Kansal A, Santosh, Meena, Kumari S, Kaushik CP. Heavy metal contamination of river Yamuna, Haryana, India: Assessment by metal enrichment factor of the sediments. J Hazard Mater. 2009;164(1):265-70.

16- Kumar Sharma R, Agrawal M, Marshall F. Heavy metal contamination of soil and vegetables in suburban areas of Varanasi, India. Ecotoxicol Environ Saf. 2007;66(2):258-66

17- Sankar TV, Zynudheen AA, Anandan R, Viswanathan Nair PG. Distribution of organochlorine pesticides and heavy metal residues in fish and shellfish from Calicut region, Kerala, India. Chemosphere. 2006;65(4):583-90.

18- Singh A, Sharma RK, Agrawal M, Marshall FM. Health risk assessment of heavy metals via dietary intake of foodstuffs from the wastewater irrigated site of a dry tropical area of India. Food Chem Toxicol. 2010;48(2):611-9.

19- Srinivasa Gowd S, Ramakrishna Reddy M, Govil PK. Assessment of heavy metal contamination in soils at Jajmau (Kanpur) and Unnao industrial areas of the Ganga Plain, Uttar Pradesh, India. J Hazard Mater. 2010;174(1-3):113-21.

20- Vijayanand C, Rajaguru P, Kalaiselvi K, Selvam KP, Palanivel M. Assessment of heavy metal contents in the ambient air of the Coimbatore city, Tamilnadu, India. J Hazard Mater. 2008;160(2-3):548-53.

21- Zhuang P, McBride MB, Xia H, Li N, Li Z. Health risk from heavy metals via consumption of food crops in the vicinity of Dabaoshan mine, South China. Sci Total Environ. 2009;407(5):1551-61.

22- Bhattacharyya P, Chakrabarti K, Chakraborty A, Tripathy S, Kim K, Powell MA. Cobalt and nickel uptake by rice and accumulation in soil amended with municipal solid waste compost. Ecotoxicol Environ Saf. 2008;69(3):506-12.

23- Greger M, Malm T, Kautsky L. Heavy metal transfer from composted macroalgae to crops. Eur J Agron. 2007;26(3):257-65.

24- Singh RP, Agrawal M. Variations in heavy metal accumulation, growth and yield of rice plants grown at different sewage sludge amendment rates. Ecotoxicol Environ Saf. 2010;73(4):632-41.

25- Zeng F, Ali S, Zhang H, Ouyang Y, Qiu B, Wu F, Zhang G. The influence of pH and organic matter content in paddy soil on heavy metal availability and their uptake by rice plants. Environ Pollut. 2011;159(1):84-91.

26- Bennett JP, Chiriboga E, Coleman J, Waller DM. Heavy metals in wild rice from northern Wisconsin. Sci Total Environ. 2000;246(2-3):261-9.

27- Organization INS. Food & feed-maximum limit of heavy metals, in 2013. Iranian National Standardization Organization; 2013. Available from: http://isiri.org/portal/File/ShowFile.aspx?ID=a02570df-ac29-42a6-87f3-7282ebc2b147.

28- Malakootian M, Yaghmaeian K, Meserghani M, Mahvi AH. Determination of Pb, Cd, Cr and Ni concentration in Imported Indian Rice to Iran. Iran J Health Environ. 2011;4(1):77-84.

29- Zazouli MA, Bandpei AM, Ebrahimi M, Izanloo H. Investigation of Cadmium and Lead contents in Iranian rice cultivated in Babol Region. Asian J Chem. 2010;22(2):1369-76.

30- Khaniki GRJ, Zazoli MA. Cadmium and Lead contents in rice (Oryza sativa) in the north of Iran. Int J Agric Bliol. 2005; 7(6):1026-9.

31- Neghab M, Hoseinzadeh K, Hasanzadeah J. Assessment of Hematotoxic effects of occupational exposure to unleaded petrol. Iran Occup Health. 2013;9(4):1-12.

32- Zazoli MA, Bazerafshan E, Hazrati M, Tavakkoli A. Determination and estimation of Cadmium intake from Tarom rice. J Appl Sci Environ Manag. 2006;10(3):147-50.

33- Karimzadeh L, Bagheri GhA, Pour Ali A, Gholipour M, Mohammadi Z, Moshrefi B. Evaluation of Lead, cadmium and Copper in black tea leaves in Mazandaran factories, spring and summer 2011. J Mazandaran Univ Med Sci. 2013;23(99):2-10.