

# Study of The Concentration of Arsenic, Cadmium and Lead Heavy Metals in Various Domestic and Imported Rice of Iran

Roya Behrouzi<sup>a</sup>, Mohammad Hosein Marhamatizadeh<sup>b</sup>, Shahram Shoeibi<sup>c\*</sup>, Vadood razavilar<sup>a</sup>, Hossein Rastegar<sup>c</sup>, Keysan karimane<sup>d</sup>

<sup>a</sup>Department of Food Industries, Islamic Azad University, Tehran, Iran.

<sup>b</sup>Department of Food Hygiene, Faculty of veterinary medicine, Kazerun Branch, Islamic Azad University, Kazerun, Iran.

<sup>c</sup>Food and Drug control laboratories, Food and Drug Deputy, Ministry of health and medical education, Tehran, Iran.

<sup>d</sup>Department of Pharmacy, Farooqia college of Pharmacy, New Dehli, India.

\*Correspondence should be addressed to Dr. Shahram Shoeibi, Email: shoeibi@yahoo.com

## A-R-T-I-C-L-E-I-N-F-O

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## A-B-S-T-R-A-C-T

**Background & Aims of the Study:** The pollution of soil and water by heavy metals is considered as the most important environmental tension for plants. These metals can endanger human life through food chain. Rice, one of the high consumption types of grains in the world, is widely seen in the diet of people. Thus, present research seeks to evaluate the levels of Arsenic, Cadmium and Lead in various domestic and imported rice in Iran.

**Materials & Methods:** This study is descriptive and cross-sectional where 8 types of commercial brand of various domestic and imported rice of Iran (56 samples) were provided and numbered with codes 1- 8. The atomic absorption Machine was applied to investigate the levels of studied heavy metals.

**Results:** Results clarified the highest amount of Arsenic was in no. 8, cadmium and lead in no. 5 and the minimum amount of Arsenic was observed in no. 6, and cadmium and lead in no. 1. Also, LOD and LOQ used for determining the rate of heavy metals, indicated 0.001ppm and 0.003 ppb for lead, 0.058 ppm and 0.177 ppb for cadmium and 0.000586 ppm and 0.001758 ppb for Arsenic.

**Conclusion:** In the end, according to some studies, and the results of present study; also, given the importance of healthy and non-polluted food, the necessity of monitoring acts including measurement of agricultural products and nutrition in perspective of the methods of heavy metals remainders presence is proved.

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## Background

Arrival of heavy metals into environment is along with development and industrialization and is one of the subjects of present age. The sources of spreading heavy metals are completely different. Besides the natural sources, the arrival of these metals into environment is starting to grow through artificial factors, i.e., utilizing phosphate fertilizers, fossil fuels, industrial waste-waters

and traffic. Recently, the general pollution caused by heavy metals is rising that it is led to create a risky situation following the accumulation of these metals in plants and animals. Besides their serious damage to the health of these creatures, the use of their end product is detrimental for human (1,2). Encountering some of them through water and food substances can cause acute, chronic and dangerous poisonings (3). Among heavy metals, elements such as lead, cadmium and

arsenic are Zion-biotic, in this sense that they are not required for body metabolism and even their small quantities are harmful to body (4,5). Heavy metals are not metabolized in body, in fact, after arrival to body, they are not disposed of the body and are accumulated in it. This causes diseases and numerous complications in the body including spreading viral, bacterial and fungal infections. Also, heavy metals replace other salts and minerals required by body. These materials deposit in vascular tissues, muscles, bones and joints (6). Poisoning by heavy metals can lead to the complications such as neurological disorders, types of cancers, nutrient poverty, disorder in the balance of hormone, abortion, respiratory, vascular and cardiac disorders, damage to liver, kidneys and brain, allergy, anorexia, early aging, memory decrease, hair loss, osteoporosis, insomnia, impairment of immune system, anemia, destruction of genes and even death (7,8).

The main problem in regard with heavy metals is their non-biodegradability. Metal compounds can change but still remain. This stability allows them to be transferred by water or food chain. Accordingly, the stability (sustainability) of heavy metals appears at upper levels of food chain that can be accumulated several times more than their rate in air, water or food. Thus, it can endanger the animals and plant which are in this chain (9,10).

Given this issue and the international nature of growing importance of food in recent years, the attention of public and supervising organizations in food sector, especially world commerce organization has seriously been concentrated on the security of food and estimating its quality. The security chain of food should be monitored from the farm to food table (6). Meanwhile, rice, as one of the highly consumed grains in the world, is broadly observed in people's diet and according to FAO's report around 30% of energy source and 20% of protein source of the world are provided through rice consumption (10,11). Rice is

considered as the main diet of more than half of the people in hot and semi-hot areas of the world and it is considered the second high consumption grain in Iran. Also, it is used in different forms in preparing foods, types of cookies and cakes. So, the pollution of this product can endanger human health. With this attitude, the assessment of the rice pollutants level is essential (12).

In the rice of countries with record of pollution in the fields such as Pakistan, Thailand and Oregua, pollution with heavy metals is observed (13). For instance, in Thailand, pollution with lead has caused half of the infants born in Bangkok to be polluted by poisoning by this toxic and dangerous metal (14). Pakistan is among the countries that continuously tests and monitors its agricultural products including rice in perspective of the rate of pollution by heavy metals (15,16). The source of these pollutions is related to inappropriate irrigation water, lack of controlling industrial sewage of factories and uncontrolled use of toxins containing metals like cadmium that leads to directing deposits of heavy metals into the plantations and finally result in declining the quantity and quality of rice and allowing numerous dangers. Heavy metals, e.g., lead and cadmium have the property of bio-accumulation in the tissues of human, animals and plants. Thus, the dangers of consuming a food stuff polluted with heavy metals, e.g., lead, cadmium and arsenic, even in small quantities are high (14).

#### **Aims of the study:**

This study was to assess the concentration of Arsenic, Cadmium and lead heavy metals in different types of domestic and imported rices in Iran.

#### **Materials & Methods**

In this descriptive cross-sectional study, first, 8 commercial brands of various imported and domestic consumable best-seller rice were prepared from popular brands from different provinces. Then, of total commercial brands,

fifty six 300-g samples were selected in random and transferred to Food and Drug Reference Laboratory of Ministry of Health and were kept in refrigerator until the experiment. To remove the probable pollution, all laboratory dishes were washed in acid and rinsed in deionized water and dried in oven. For prepare the rice, the samples were first washed and were put in oven at 80 degrees Celsius and after drying, 2 g were weighed from each 300-gram sample and were kept at 105 degree Celsius for 48 hours. Then, 10 ml perchlorate acid 70% and 5 ml sulphuric acid and 30 ml nitric acid 70% were added and was kept at laboratory temperature for half an hour and then, they were put on the heater in order to boil the solution gently until a clear solution of 25 ml is achieved (17). The prepared samples were kept in the refrigerator until all the samples were ready. To assess the amount of heavy metals under study in different samples of rice, the Atomic Spectrometer Machine, with Flame Model, shimudze- AA-670 was used. The acids used, were purchased from Merck Company, Germany. To analyze the data, Excel 2010 and the software of the Machine itself (Spectra AA) were applied.

#### Preparing Calibration Curve

To prepare the standard solution, first, a solution with concentration of 100 ppm with Mark, Pancreas, was prepared from lead, cadmium and arsenic stock solution. Then, 0.5 ml of the standard 100 ppm was taken and the volume 50 ml was achieved and in this way a standard solution with concentration of 1 ppm was obtained. The standard 50 pp b was used to draw the curve and the Machine based on work concentrations, prepared and injected 5, 10, 20 and 50 ppb for lead, 2.5, 5, 10 and 20 pp b for cadmium and 2.5, 5, 20 and 10 pp b for arsenic. Calibration curves had acceptable linear criteria of 0.9997 for lead, 0.9992 for arsenic and 0.9996 for cadmium that these figures indicate the accuracy of calibration curve and concentrations determined by it.

#### Determining LOD (Limit of Detection) and LOQ (Limit of Quantification for each of value-determining Methods

LOD is indicative of the least amount of analytic in the sample. This is the detectable method applied and LOQ is indicative of minimum concentration of the desired analytic that can be determined with appropriate accuracy and care. The values of LOD and LOQ were calculated using ICH (International Conference on Harmonization) method, where SD is the Standard Deviation of the Blank samples concentration and S is the slope of calibration curve drawn by the machine (Equation 1, 2).

$$LOQ = \frac{10 \times SD}{S} \quad (1)$$

$$LOD = \frac{3.3 \times SD}{S} \quad (2)$$

#### Results

The mean and criterion deviation of pollution with heavy metals of lead, cadmium and arsenic in the samples of rice collected, have been presented in tables 1 and 2 and Diagram 1. As the results show, the rice samples are polluted with arsenic. The amount of arsenic in the rice under study was higher than the allowed limit determined by Iran's Standard Institute (table 1). Among the positive samples, arsenic with 46.4% had the highest abundance and lead and cadmium had the least abundance (bellow allowed limit). Also, in this study pollution with arsenic was observed in imported rice. In domestic rice pollution with arsenic was not observed (Table 2 and Figure 1).

**Table. 1) Mean and Standard deviation of the amount of heavy metals in different samples of Iranian and imported rices (in ppb)**

Name of metal Brand Code	N	As		Cd		Pb	
		Mean	SD	Mean	SD	Mean	SD
1	4	92.5	18.92	8.75	1.5	17.5	9.54
2	11	120.9	55.93	10	5.04	45.54	27.18
3	4	60	37.45	10.87	0.86	42.5	9.57
4	3	86.67	11.54	10.33	0.56	56.66	30.55
5	3	36	5.29	48	33.04	101.33	28.93
6	3	31.5	2.12	25	7.08	55	21.22
7	4	62.5	35.93	18.5	13.27	32.75	28.46
8	24	183.4	51.16	*LOQ>	LOQ>	34.29	6.81

\* LOD and LOQ used for determining the rate of heavy metals, indicated 0.001ppm and 0.003 ppb for lead, 0.058 ppm and 0.177 ppb for cadmium and 0.000586 ppm and 0.001758 ppb

**Table 2) Mean of pollution for metals under study in different metals under study and samples of domestic and imported rice**

Imported			
Teste system	Pb	Cd	As
Sample size	53	53	53
Positive(%)	0	0	46.4
Range (ppb)	10-116	<LOQ-70	10-260
Mean(ppb)	33.09	15.3	128.9
MRL <sup>b</sup>	150	60	150
Domestic			
Teste system	Pb	Cd	As
Sample size	3	3	3
Positive(%)	0	0	0
Range (ppb)	10-30	6-8	80-90
Mean(ppb)	16.6	7	86.6
MRL <sup>b</sup>	150	60	150

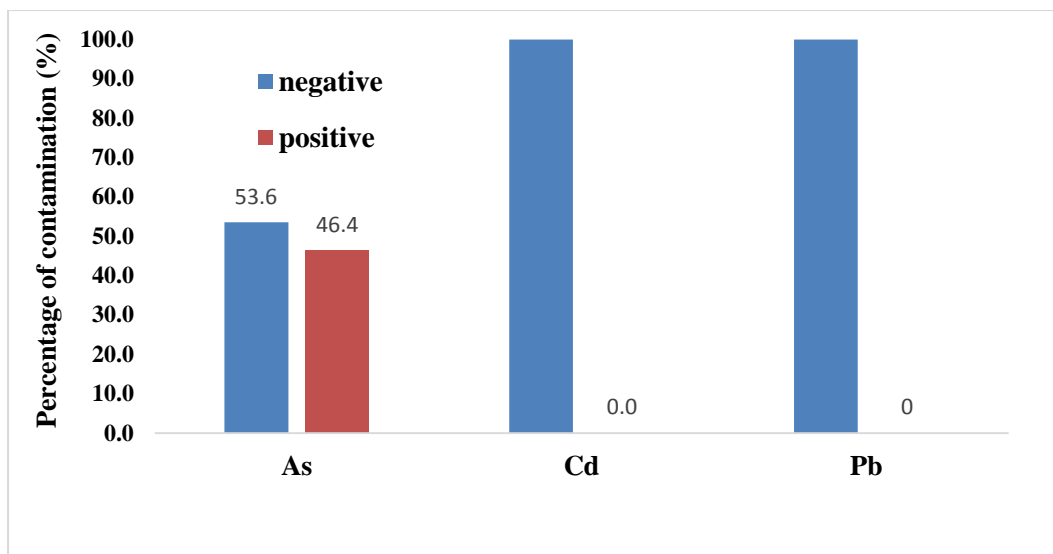


Figure 1) Frequency percentage of pollution of different types of domestic and imported rice with heavy metals

## Discussion

Results showed that the mean level of concentration in all samples for arsenic was (107.3 ppb), lead (43.4 ppb), and cadmium (19.4 ppb) that is consistent with the results of study by Shokrzadeh and colleagues (18). In the study by Shokrzadeh *et al.* (2014) three heavy metals of lead, cadmium and chrome were studied in imported Indian rice and Tarum domestic rice produced in Golestan province. Results showed that cadmium had the least amount in both types of rice studied and the amount of lead in both types, that is, imported and domestic was almost the same and the amount of cadmium in domestic rice was more than that of the imported one. Also, results of study by Adibi *et al.* (2014) revealed that among the heavy metals under study (lead, cadmium and arsenic), lead had the highest concentration and cadmium had the least concentration of heavy metals in the samples of rice under study (19). Also, results of study by Mosayebi *et al.* (2014) showed that among the heavy metals under study (cadmium, lead and arsenic) in different types of rice under study, the highest and lowest amount of heavy metals concentration belonged to lead and arsenic,

respectively (20). That was not consistent with the result of present study. In the study by Mosayebi *et al.* the mean concentration of lead, arsenic and cadmium in the sample imported rice from India and Pakistan and Golestan city were reported 0.067, 0.007 and 0.024 mg/kg that were less than the allowed limit determined by National Standard Organization of Iran. In this study, arsenic had the highest amount of concentration and cadmium the lowest concentration of the heavy metals. The study conducted by Yamily *et al.* (2008) in New York on 204 samples of commercial rice from the north of New York state, Canada, France and Venezuela, revealed that the range of rate of arsenic was between 0.08 and 0.2 ppm and the polluted water was along with the different rates of arsenic (21). Kao *et al.* (2010) reported the mean concentration of cadmium and lead 0.014 and 0.054 mg/kg of dried weight of rice in Giangsu province in China (22). Cabata Pendas reported the amount of cadmium in the world grain in the range of (0.013–0.22) and lead (0.1–1.08) mg/kg (23). In present study, the cadmium concentration was in the range of 8.75–48 ppb, lead 101.33–17.5 ppb and arsenic 31.5–183.4 ppb (table 1). Variables such as environment and geographical position, method

of cultivation, variety of product, seasons and the conditions of the soil are the most important factors in changing the elements of rice samples. Thus, the difference in the rate of metals may be attributed to this in different types of rice (24). Given that metals such as lead, cadmium and arsenic are important elements of earth crust and their widespread application, in a study carried out a study on the soils of southeast of Asia (Thailand) is reported that the heavy metals of arsenic, cadmium, cobalt, chrome, copper, mercury, nickel, lead and zinc are accumulated in accessible amounts in soil and then, they are transferred into plants and agricultural crops through soil. They also found the relationship between the amount of these metals in soil and their concentration in plants (25).

## Conclusion

Results of samples under study illustrated that the pollution levels of the imported rice with different types of heavy metals was lower than that of domestic ones and, in all studied rice, arsenic had the highest concentration and cadmium the lowest concentration. Also, considering the importance of consuming healthy diet and free of pollutants, the requirement of controlling measurements in assessment of agricultural products and food stuff is determined or confirmed in viewpoint of the presence of the remainder of heavy metals.

## Footnotes

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### Conflict of Interest:

The authors declared no conflict of interest.

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