RESEARCH ARTICLE

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Evaluation of Lead and Cadmium Levels of Iranian and Imported Rice in Kermanshah, 2016 (Iran)

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Background & Aims of the Study: One concern of human is heavy metals pollution of food products such as rice. It is a fact that rice is one of the most consumed items in the diet of Iranian people. This study was conducted to evaluate lead and cadmium levels of Iranian and imported rice in Kermanshah city, Iran, 2016.

Materials & Methods: This descriptive- analytical and cross sectional study is conducted in Kermanshah, 2016. In this study, 30 Iranian and imported rice samples were selected and sampled. The concentrations of heavy metals (lead and cadmium) were collected, using ICP-OES machine in order to read and compared with the standard values of Food and Drug Administration; also, Food and Agriculture Organization (FAO) standard. In this study, one-sample t-test and SPSS (version 16) were applied to data analysis. The significance level in all tests was considered (α=0.05).

Results: The results showed that the cadmium average of imported and Iranian rice were 1.318 ±0.158 ppm and 1.191 ±0.834, respectively, which were higher than the standard of Food and Drug Administration and FAO. Also, the lead average of imported rice was 8.889 ppm with a standard deviation of 12.179 and 8.659 ppm and a standard deviation of 8.143 for Iranian rice which were higher than the standard of Food and Drug Administration and FAO; the difference was statistically significant.

Conclusion: The comparison of lead and cadmium heavy metals concentrations with the standard level showed the concentration of them in both Iranian and imported rice was completely above the standard. Considering the cumulative effects of heavy metals and its adverse effects on human societies, as well as the threat of food security needs to be paid special attention and periodic studies should be undertaken to provide more comprehensive information.

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Background

In many parts of the world, rice is the main source of food and supplies the major part of people's energy. According to World Food and Agriculture Organization (FAO), 29.3% of energy and 25.3% of protein are provided through rice in developing countries (1). Currently, Iran is one of the biggest rice

importers in the world as well as rice producer (2). Rice carbohydrate content is supplied the carbohydrate in the diet of Asian countries, including Iran (2,3). Regarding the high consumption of rice in Iran and around the world, concern about the possible contamination of rice with heavy metals has increased (4). Heavy metals are considered as environmental pollutants that human exposure to some of them through water and food can cause acute, chronic and dangerous poisoning (5). Heavy metal poisoning can lead to complications such as neurological disorders, types of cancer, nutrient deficiency, hormonal imbalance, abortion, respiratory distress, cardiovascular damage, liver, kidneys, brain damages, allergies, Anorexia, premature aging, memory loss, hair loss, osteoporosis, insomnia, weakening of the immune system, blood counts, gene degradation and even death (6,7). Heavy metals such as lead and cadmium are not needed for body metabolism, and even small amounts of them are harmful to the body (4). Heavy metals are generally insoluble, so, they resist environmental ecosystems for a long time. Among the main agricultural products, rice is a special product with high adsorption and accumulation of cadmium, lead and arsenic (4). Cadmium and lead are mainly in natural and agricultural environments through various activities such as agriculture, mining and industrial as well as gases which are distributed from the car's exhaust (8). These metals have a high potential toxicity and traceability including the most dangerous materials for the environment and human. They remain in the environment for a long time (9,10) because of high mobility and also not decomposing. Cadmium and lead in soil are easily absorbed by plants and can be present in low concentrations in products that are significantly exposed to humans (11). Lead has the highest amount in the environment among the heavy metals (12). Some examples of lead poisoning include sudden death, neurological symptoms, sudden contractions of the muscles, anemia, swelling of the stomach and intestine, epithelium hemorrhage, and kidney and liver degeneration (13). Excessive accumulation of cadmium in the body can lead to some diseases, such as prostate cancer, high blood pressure, testicular tissue and red blood cells damage, kidney sting and coagulation of some proteins; also, the disease of Itai-Itai, which is associated with bone fractures and severe pain (14). In a study conducted in Malaysia in 2009, various rice plants contain heavy metals such as lead and cadmium; cadmium is uniformly distributed throughout all parts of the plant (15). Bennett et al reported an average concentration of cadmium, lead and arsenic in North American rice grains 0.136, 0.016 and 0.250 mg/kg (16), respectively. Cao et al reported an average concentration of cadmium and lead in Chinese rice samples, 0.014 and 0.054 mg/kg, respectively (17). Mosayebi and Merzaie reported lead, arsenic and cadmium concentrations among imported rice samples from India and Pakistan were 0.067, 0.007 and 0.024 mg/kg (18). Zazouli et al. reported the average cadmium concentration of rice in the city of Ghaemshahr was 0.4±0.16 micrograms per kilogram (19). Ghazanfari Rad et al, in a study on rice samples heavy metals in Qaemshahr reported lead values were 0.916±0.035 and cadmium 0.022±0.027 ppm (20). The study of Shakerian et al on several rice brands in central Iran showed lead and cadmium levels were 0.062±0.019 ppm and 0.068±0.0185 ppm, respectively (21). The review of valid scientific literature in the world implies the adverse effects of these elements on biological systems and considered as global health threats.

Aims of this study:

Considering the high consumption of rice in Kermanshah city as well as the presence of various types of Iranian and foreign rice in the city and lack of accurate information on lead and cadmium levels, the present study aims to investigate the level of lead and cadmium of

Iranian and imported rice in Kermanshah city markets, 2016.

Materials & Methods

This descriptive-analytical and cross sectional study is conducted in Kermanshah, 2016. In this study, 30 Iranian and imported rice samples are selected. For sampling, each of them was weighed 1 kg and a total of 30 kg of rice have been prepared. After collecting and transferring rice samples to the laboratory, rice samples have been washed off by distilled water and dried in an oven for 48 hours at 105 °C. The amounts of 2 grams of rice milled samples have been placed in Chinese bushes in an electric oven at 650 °C for 5 hours to prepare rice ashes. At first, 5 ml of concentrated nitric acid is poured on the ash and heated on the heater until evaporation of the added acid. Then, 10 ml of nitric acid 10% is added to the sample, the obtained solution has been passed from Watman 42 filter paper, fed into a 50 ml volumetric balloon and diluted with dilute nitric acid (22). To measure heavy metals in rice, the ICP-OES machine in724-ES model manufactured by Varian Corporation of the United States was used. The values, which were obtained from lead and cadmium metals, have been evaluated three times and compared with the standard amounts of Food and Drug Administration and FAO. Finally, the data were analyzed, using one-sample t-test in SPSS version 16 and analyzed at confidence level of (α =0.05).

Results

In this study, 30 samples of Iranian and imported rice are evaluated for lead and cadmium levels. For this purpose, 12 types of Iranian rice and 18 imported rice (Indian, Pakistani, etc) are examined for these elements. The P values were 0.446 and o.899 for lead and cadmium, respectively, which are demonstrated that there is no significant difference between the average of lead and cadmium levels in Iranian and imported rice.

Table 1) Comparison of lead and cadmium elements in Iranian and imported rice

Element	Imported		Iranian		Test statistic	$P_{\text{-value}^*}$
	Standard deviation	Average	Standard deviation	Average		
Lead	12.179	8.889	8.143	8.659	- 0.762	0.446
Cadmium	0.158	1.318	0.834	1.191	- 0.127	0.889

* Man Whitney Test Results

The results of single-sample t-test indicate that the cadmium average in imported rice (1.318±0.158 ppm) is higher than the recommended standard of Food and Drug Administration (P=0.001) and the FAO (P=0.009), and this difference is significant statistically.

The results of this study show that the average cadmium content of Iranian rice is 1.191 with a standard deviation of 0.834 ppm, which compared to the standard Food and Drug Administration (P=0.001) and FAO (p=0.004) which is higher than the permitted level with a statistically significant difference.

Analysis showed that the lead average in Iranian rice is 8.659 with a standard deviation of 8.143 ppm, which compared to the standard Food and Drug Administration (P=0.004) and FAO (p=0.005) which is higher than the permitted level and this difference is statistically significant.

Table 2) Single-sample t-test results for comparison of lead and cadmium average levels in Iranian and foreign rice with the standard of Food and Drug Administration

Element	Rice type	Average difference	Comparison basis	t	P_{-value}
Cadmium	Iranian	1.091	ppm0.1	4.530	0.001
	Imported	1.218		7.672	0.001
Lead	Iranian	8.459	ppm0.2	3.598	0.004
	Imported	8.689		3.027	0.008

Table 3) Single-sample t-test results for comparison of lead and cadmium average levels in Iranian and foreign rice with FAO standard

Element	Rice type	Comparison basis	Average difference	t	P_{-value}
Lead	Iranian	0.3ppm	8.835	3.556	0.005
	Imported		8.589	2.992	0.008
Cadmium	Iranian	0.4ppm	0.791	3.285	0.007
	Imported		8.489	2.957	0.009

Discussion

The findings of this research showed that the average concentration of lead and cadmium in imported rice were higher than Iranian rice. The average of cadmium and lead, obtained in current research, was considerably higher than permitted level by the Ministry of Health's Food and Drug Administration (0.1 ppm for cadmium and 0.2 ppm for lead). According to Bakhtiyarin et al. report about the rice of the northern part of Iran, the highest amount of Lead and cadmium in Hasani rice was about 0.965 ppm and 0.0793 ppm, respectively (23). As can be seen, the values of lead and cadmium in the study were more than this study. The results of study about cadmium, chromium and lead levels in imported Indian rice and Tarom rice in Golestan by Shokrzadeh et al, showed that there was a significant difference between the values of metals in rice of different regions of Golestan province. Also, the amount of lead in total Indian rice is generally not different from its amount in Iranian rice; however, Iranian rice had more cadmium and Indian rice had more chromium (12). Variables such as the environment and geographical area, crop cultivation, variety of rice, seasons and soil conditions are the most important variables of rice samples (12). Therefore, the existing differences may be related to these variables. Al-Saleh and colleagues investigated the value of lead and cadmium in rice samples and reported an average of 0.02 mg/kg for cadmium and 0.135 for lead (24), which is lower than the current study.

Watanabe et al conducted a study about cadmium in rice around the world (around 17 regions of Asia, in particular Asia). A total of 1546 samples were analyzed and the data showed that the highest amount of cadmium in Asia was 55.70 ng/g and outside of Asia was 133.20 (25). Watanabe et al. showed the cadmium concentrations of rice in various countries ranged from 0.0008 to 0.13 mg/kg with an average of 0.03 mg / kg (25). Zhang et al. found the concentration of lead in rice samples in 10 regions of Asia which the highest and lowest levels were in Indonesia (38 ng /g) and Australia (2 ng/g) respectively, and in the one region, outside of Asia, the highest was Spain (58 ng/g) and the lowest in the United States (3 ng/g) (26). In a study in Lorestan province, a total of 99 samples of rice planted in important areas of this province were investigated. The findings showed that the differences between lead and cadmium in

different cities were significant and the amount of them in each city was less than permitted level. Comparison of the total lead content of the samples with the permitted level showed that the concentration of lead in the samples was less than the permitted limit. The significant difference in the concentration of cadmium in comparison with the limit was found which was low in Khorramabad samples; however, this difference was not significant. In the case of Boroujerd and Dorood, the value was significantly below the permissible limit. The results of current research presented that the concentration of lead in Indian and Iranian rice was much higher than Lorestan rice which were above the permitted level; but, the cadmium content of Indian rice was lower than Lorestan rice and below the permitted limit; however, Iranian rice had more cadmium and was above the permitted limit (27). The results of the another study about cadmium, chromium and lead concentration in Champa rice of Mobarakeh showed that 40% of samples had higher cadmium content than standard; however, all samples were lower than standard in terms of lead and chromium (28). Given that these metals were important elements of the Earth's crust, and given their widespread use, Zarcinas et al conducted a study on Southeast Asian soils (Thailand) and reported that heavy metals (arsenic, cadmium, cobalt, chromium, copper, mercury, Nickel, lead and zinc) accumulate in soil in accessible form, then transported through the soil to plants and agricultural products. They also found a relationship between the amount of these metals in the soil and their concentration in the plants (29).

Conclusion

This study was conducted to evaluate the levels of lead and cadmium of Iranian and imported rice in Kermanshah. This descriptive - Analytical - cross-sectional study is conducted in Kermanshah in 2016. The results showed that the cadmium average in the imported rice and Iranian rice, was higher than the standard of Food and Drug Administration and the standard level of FAO. Also, the lead average in the imported rice and Iranian rice was higher than the standard of Food and Drug Administration and the standard level of FAO and the difference was statistically significant. Considering the cumulative effects of heavy metals and its adverse effects on human societies, as well as the threat of food security, special attention and periodic studies should be undertaken to provide more comprehensive information.

Footnotes

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Conflict of Interest:
The Authors have no conflict of interest.

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