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Cadmium Contamination in Rice Cultivation in Savadkooh Region, North of Iran

Ghazal Banitahmasb[1], Nazanin Khakipour[2]

[1]Department of Food Technology, Savadkooh Branch, Islamic Azad University, Savadkooh, Iran
[2]Department of Soil Science, Savadkooh Branch, Islamic Azad University, Savadkooh, Iran
Email: nazanin_kh_43713@yahoo.com

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Abstract

Potential contamination of rice by heavy metals such as Cu, Co, Cd, Ar, Cr, Hg, Ni and Pb in soil, water and pesticides affects the quality and nutritional properties of rice. The aim of this study was to evaluate the contamination of rice cultivated in the city of Savadkooh to Cadmium and its comparison with international standards. With the study on different areas of Savadkooh (city in Mazanaran Province) seven samples of rice with the soil in which they were grown were to take for sampling. According to the results, all samples had some Cadmium but the amount of Cd was less than the specified in National Standards and was safe for using.

Keywords

Cadmium, Heavy Metals, Rice, Savadkooh

1. Introduction

More than 90 percent of the world's rice is produced and consumed in Asia [1]. Introduction of agricultural waste which carries municipal and industrial pollutants can create multiple problems for the aquatic environment [2]. Notable amongst the pollutants introduced into the aquatic ecosystems are heavy metals due to their toxic effects. Heavy metals affect human beings in various ways, and contribute to or cause neurological disorders, cancer, genetic disorders and birth defects amongst other ailments [3] [4] [5].

Potential contamination of rice by heavy metals such as Copper, Cobalt, Cadmium, Arsenic, Chromium, Mercury, Nickel and Lead in soil, water and pesticides affects on the quality and nutritional properties of rice.

The increasing pollution of urban waste water and toxic ions is an issue of environmental concern these days. The role of heavy metals in environmental pol-

lution and adverse effects on humans is of extreme importance. Heavy metals are absorbed into the human body in different ways; one of these ways is by ingestion of food. The presence of heavy metals in excess of defined standards causes environmental problems for the residents and the ecosystems [5]. Among heavy metals, cadmium causes the greatest concern due to its high mobility in soil and its high toxicity even in low concentrations [6]. The most important adverse effect of cadmium intake in humans is Itai Itai, the disease caused by the consumption of contaminated rice, first reported in Japan [7]. In one research about Hindi imported rice in Iran by Malakootian and Yaghmaeian in 2010, titled Evaluation of Pb, Cd, Ni and Cr in Hindi rice, samples of 20 different kinds of popular imported Hindi rice were gathered and tested [8].

Studies by scientists, to determine the amount of Cd, Cu, Pb, Hg, Ar, Se, Mn and Zn in rice and fish showed the ICP-MS method to be more precise than the atomic absorption method [9].

In 2008, Zazouli and his research team showed that the average concentration of Cadmium in the rice from Qaemshahr (Mazandaran province) was 0.16 - 0.40 micrograms per dry weight and a range of 0.12 - 0.83 micrograms per dry weight [10].

The aim of this study was to evaluate the contamination of rice cultivated in the city of Savadkooh to Cadmium and its comparison with international standards.

2. Materials and Methods

With the study on different areas of Savadkooh (a city in Mazanaran Province), seven samples of rice with the soil in which they were grown was taken for sampling (**Figures 1-4**). All samples were taken from landscape called plain and tested with three replicates. To perform the ashes test tube in a furnace to a maximum temperature of 500˚C ± 50˚C for minimum 8 hours was performed. After the conversion of the ash sample, 50 mL of 6 M Rick acid chloride was added into the crucible, so that all the contents of ash, was treated with acid. Then put the crucible on a water bath or heater, acid was added to evaporate. In order to solve the remaining contents of the crucible, the amount of 10 to 30 mL of 1.0 M nitric acid was added to the crucible, until all the contents of the acid was applied [11].

For the measurement of Cadmium element of optical atomic absorption spectrometry was used to adjust the measuring device in relation to elements, such as adjusting the wavelength necessary gas flow rate, temperature and adjust the programming device other factors, based on the instructions provided by the manufacturer of the device [11].

Soil samples were air dried and crushed using a plastic hammer and was sift from a 2mm sieve. Soil collected under the sieve was used for chemical analysis [12]. To measure the concentrations of heavy metals in soil DTPA extractant with calcium chloride and triethanolamine was used and the solution pH was

Figure 1. Study area map (Polesefid and Zirab).

Figure 2. Study area map (Shirgah).

Figure 3. Study area map (Beshel).

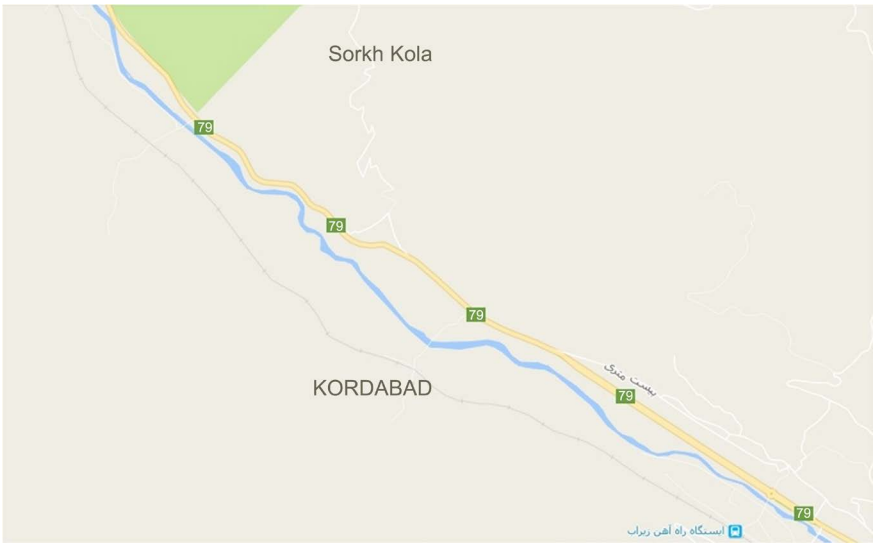

Figure 4. Study area map (Sorkh Kola).

adjusted juicer about 7.3 [13]. The heavy metal concentrations were measured by atomic absorption Perkin Elmer AAS 4100.

3. Results and Discussion

In this section, we compare the average heavy metal cadmium in rice in Savadkooh region with one sample t-test was used as standard. The results are shown in **Table 1** and **Table 2**.

In order to evaluate the average cadmium in rice Savadkooh city standard level (0.06 ppm) one -sample T-test was used. The average cadmium in rice of Savadkooh region (0.0014 ± 0.0073) was significantly lower than standard ($P < 0.001$;. In other words, the confidence interval for the amount of cadmium in rice of Savadkooh was not reaching the standard and was below it (**Figure 5**).

Table 1. Results of samples tested.

Type		N	Minimum	Maximum	Mean	Std. Deviation
Tarom A	Cd_B	3	0.0060	0.0090	0.0076	0.0015
Tarom B	Cd_B	3	0.0070	0.0080	0.0073	0.0005
Tarom C	Cd_B	3	0.0080	0.0090	0.0083	0.0005
Tarom Shamsi	Cd_B	3	0.0050	0.0050	0.0050	0
Tarom Hashemi A	Cd_B	3	0.0060	0.0070	0.0063	0.0005
Tarom Hashemi B	Cd_B	3	0.0090	0.0090	0.0090	0
Tarom Ghermez	Cd_B	3	0.0070	0.0080	0.0073	0.0005

Table 2. The results obtained from soil samples tested.

Type		N	Minimum	Maximum	Mean	Std. Deviation
Tarom A	Cd_Kh	3	0.0090	0.0110	0.0100	0.0010
Tarom B	Cd_Kh	3	0.0080	0.0100	0.0090	0.0010
Tarom C	Cd_Kh	3	0.0120	0.0130	0.0123	0.0005
Tarom Shamsi	Cd_Kh	3	0.0050	0.0090	0.0070	0.0020
Tarom Hashemi A	Cd_Kh	3	0.0070	0.0080	0.0073	0.0005
Tarom Hashemi B	Cd_Kh	3	0.0090	0.0100	0.0093	0.0005
Tarom ghermez	Cd_Kh	3	0.0080	0.0110	0.0093	0.0015

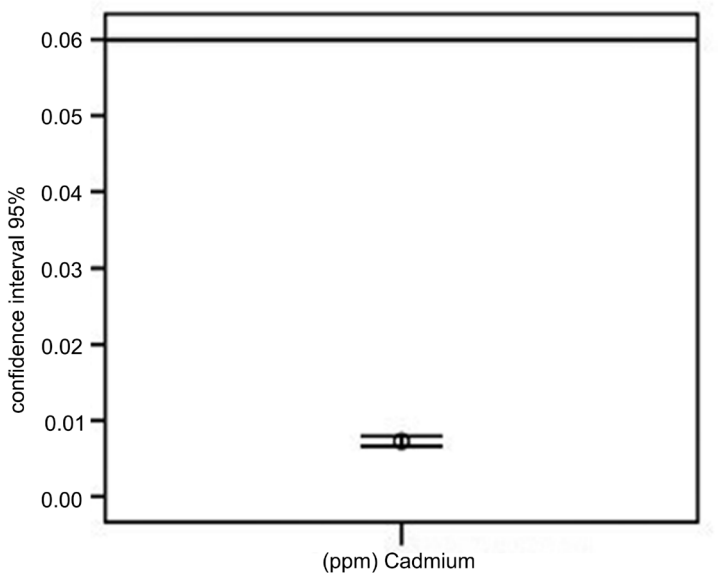

Figure 5. 95% to the amount of cadmium in rice Savadkooh city with national standards.

Comparison of Cadmium in This Rice with the International Standard (Codex)

In order to evaluate the average cadmium in rice of Savadkooh city with the international standard (0.4 ppm) one-sample T-test was used. The average cad-

mium in rice (0.0073 ± 0.0014) was significantly lower than standard.

($P < 0.001$; $-1300.71 = (20)t$), in other word, the confidence interval for the amount of cadmium in rice of Savadkooh was not reaching the standard and was below it (Figure 6).

The relationship between the amount of cadmium in soil and rice:

To investigate the relationship between the amount of cadmium in soil and rice of Savadkooh city Pearson product-moment correlation coefficient was used.

As seen in Figure 7, there was a significant positive correlation between the amount of cadmium in the soil and the amount of cadmium in rice ($r = 0.649$; $p = 0.001$).

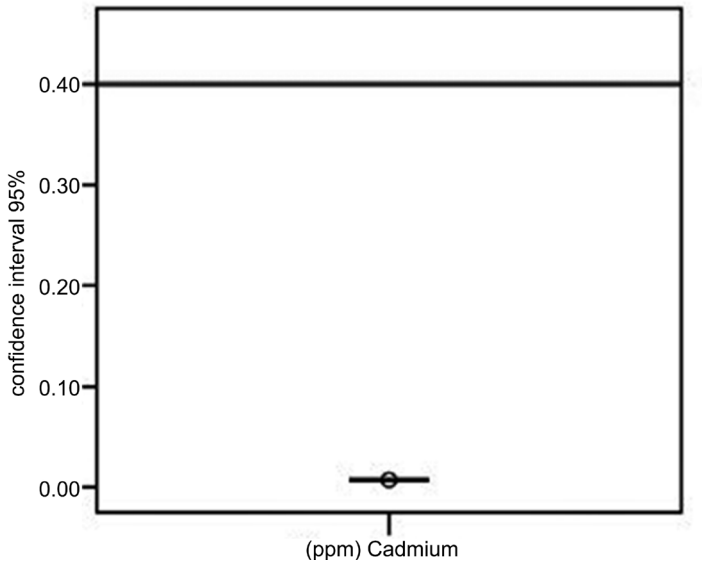

Figure 6. 95% to the amount of cadmium in rice Savadkooh city with international standards.

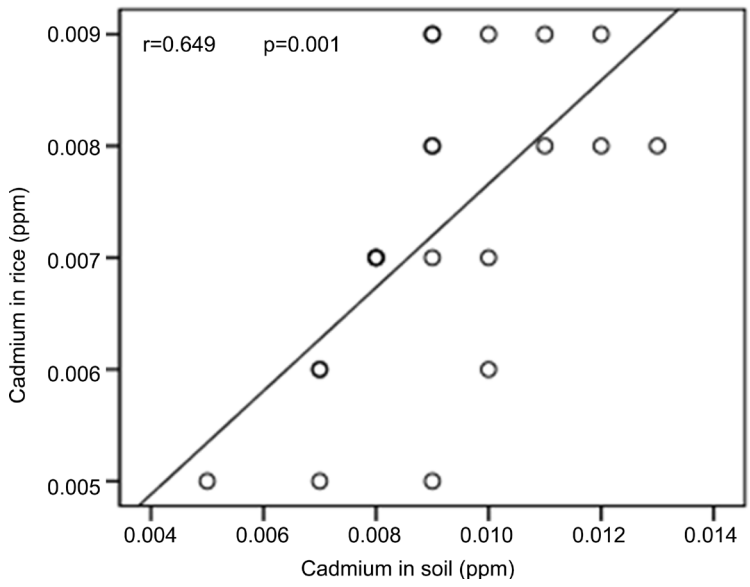

Figure 7. Relationship between the amount of cadmium in the soil and the amount of cadmium in rice.

The relationship between the amount of cadmium in the soil and rice:

Concentrations of heavy metals, especially cadmium is associated with the amount and type of organic matter in the soil.

In this study the correlation between Cadmium in the soil and Cadmium in cultivated rice was found, and this relationship was observed in all samples.

Chao and his research team (2010) found the average concentration of Cadmium and Lead in the rice in Jiangsu in china to be respectively 0.014, 0.054 mg per dry kg. These values are all below the maximum tolerable concentration in China [14].

In 1996, Zhang and his colleagues studied the concentration of Lead in samples of rice in 10 regions in aisA and found that the highest and lowest values, respectively, were those of Indonesia (38 nanograms per gram) and Australia (2 ng per gram). Seven area outside Asia were also studied; the highest numbers were found in Spain (58 nanograms per gram) and lowest in the USA (ng/g) [15].

4. Conclusion

The results indicated a significant positive correlation between the studied heavy metals in rice and soil in which they were grown. So we can conclude investigations with no worries of cultivated rice consumption in the Savadkooh region, and there is the possibility of a risk to consumer health. If the amount of heavy metals in the soil gets increase, the amount of these metals in products grown in them, will increase.

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