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Admium, Lead and Arsenic Content in Polished White Rice (*Oryza sativa* L.) In Ghaemshahr City (North of Iran)

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Abstract: Today too much consumption of chemical fertilizer for more production of agricultural product is increasing. chemical fertilizer is one of main heavy metals.Rice is main agricultural product in Ghaemshahr city and also the main food of the people of this city. This study was survey of content cadmium, lead and Arsenic in rice (*Oryza sativa* L.) in Ghaemshahr city (Vahdat Center) in north of Iran.Then heavy metals concentration has been compared with WHO standards and the maximum permitted level Standard IRAN. Indicated that the value of Asand Cd concentration in rice were (<0.005-0.051 mgkg^{-1}on dry wt) and (<0.05-0.113) respectively; Also Pb concentration in rice was (<0.05-0.135). Standard for arsenic in the polished white rice has not been determined yet. In all samples of polished white rice, Cd and Pb contents were lower the maximum permitted level for rice compared with Standard codex/EU/WHO and lower the maximum permitted level Standard IRAN. The weekly intake of As, Cd and Pb from rice was 0.319 (0.046-1.059), 0.573 (0.461-2.347) and 0.802 (0.066-2.80) µg kg^{-1} body weight/week, respectively that was lower than of total dietary As, Cd and Pb intake andthat weekly As, Cd and Pb intake from rice was down the maximum weekly intake recommended by WHO/FAO. Although the negative correlation between arsenic and lead concentrations (r = -0.257) observed but this correlation is not statistically significant (p = 0.274). Also, a weak positive correlation between arsenic and cadmium (r = 0.107) observed that again not statistically significant (p = 0.654) and another weak positive correlation between cadmium and lead concentrations observed (r = 0.136) which not statistically significant (p = 0.566). According to results gained in this article,although density of heavy metals in rice is less than standards level. chemical fertilizers are being used more by farmers. Since pepople use various rice brands, its expected health authorities study annual level of heavy metals in exported and imported rice.

Key words: Arsenic · Cadmium · Lead · Rice · Iran

INTRODUCTION

Heavy metals such as to mercury, arsenic, lead and cadmium are risky to human health [1]. Unsuitable contamination of wastewater can make agricultural products infect with Cadmium, e.g., infection of rice products with Cadmium in Taiwan [2]. So, the quality of rice is widely effective in human health [3]. Chemical fertilizers are considered one of the important sources of pollution in heavy metals [4]. According to studies conducted, it is feasible to estimate the daily intake of heavy metals (Pb, Cd, As, Cu and Zn) through rice in South Korea [5]. Studies have indicated that there is a positive relationship between Cd concentrations in soil and Cadmium in rice plant (R 2 = 0.242, p<0.010) [6]. Rice could be the best indicator for environment monitoring of cadmium especially in countries where people eat rice [7]. Lignin from rice bran has the least connection to binding heavy metal ions [8]. Arsenic is usually present in subsoil and it is carcinogen in humans. Level of gathering of arsenic in various plant parts is different, containing grains and the level is several times more than level of soil. In high arsenic regions, arsenic can be attracted to human body by rice consumption. The rice containing inorganic arsenic is carcinogenic [9]. Cd is one of the most popular environmental intoxicants to humans. One of the

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main sources of cadmium consumption is countries where people have rice, such as Iran. Cd in rice originates from soil via plant roots [10]. The results gained in Japan, where a painful disease called Itai itai had been reported in 1967, indicated that mean Cd concentration in rice samples was more than 0.02-1.06 mg kg^{-1} [11]. According to growth condition of rice plant, some forms of arsenic will be troublesome [12]. Level of arsenic concentration in rice samples of Pakistan and India sold in Australian supermarkets has been significantly lower than areas infected with arsenic. ($p<0.001$) and mean and median level of arsenic concentration in 214 rice samples was 143 and 131 µg kg^{-1} (dry weight, dw) (2-557 µg kg^{-1}), respectively [13]. Results indicated that there is a high level of correlation between shoot, husk, bran and endosperm rice tissue fractions and rice from mining areas was enriched in Pb, Cd and As [14]. Correlation analysis indicated that there exists a very close correlation between Lead and Arsenic, Arsenic and Cadmium concentrations in rice grains [15]. Today too much consumption of chemical fertilizer for more production of agricultural product is increasing. chemical fertilizer is one of main heavy metals.Rice is main agricultural product in Ghaemshahr city and also the main food of the people of this city.The purpose of this study was Survey of content cadmium, lead and Arsenic in rice (*Oryza sativa* L.) in Ghaemshahr city (Vahdat Center-in north of iran) on agricultural year of 2010.

MATERIALS AND METHODS

Site Study: Ghaemshahr is one of the active zones of agricultural (Rice) in Mazandaran province (Northern Iran). Rice cultivation in this city is 15,650 ha (2009-2010 year). The soil texture varied from sandy clay loam to loam. Annual average precipitation is 598 mm for the agricultural period (2009-2010). Vahdat Centeris one of the most important areas producing different types of High-yield rice and this study is conducted on the same figures. Rice growing season starts at May and ends up on August or September (Depending on weather conditions). Two-time application of N-fertilizer is necessary for rice: one of them before sowing and the other in the middle of the growth stages (Three stage), But generally Phosphate fertilizerand potash fertilizeris used before sowing.

Sampling Strategy: Ghaemshahr city is divided to two regions (The Mountain areas-the plain areas) and five agricultural center due to the rice planting Considering the high-yielding rice cultivation, Expected number of soil samples, Status of water supply sources farming region, Water wells were added together and a number was given to them randomly. After determination of the number of required samples and the location of water sampling, Paddy land(the high-yielding) near the well water source; rice sampling was done. About 20 polished white rice samples were collected at harvesting of rice in field and in laboratory, grains of rice were milled then to determine as content in rice, 0.5 g of each sample was refluxed in 10 mL of conc. nitric-sulfuric-perchloric acid mixture (4/1/1, v/v/v) for 1 h. Formic acid (90%) was then added drop by drop until the red-brown gas disappeared. Afterwards, deionized water was added to bring the digest to 25 mL. The resulting solution was reacted with an aqueous solution of 1% NaBH4 and 1% Na OH. To determine Cd and Pb content in rice, 0.5 g of each rice sample was refluxed in 5 mL of conc. HNO3 for 1 h and then 5 mL of 70% perchloric acid was added. The reflux was continued for another 0.5 h. After wards, deionized water was added to bring the digest to 25 mL (Lin *et al*, 2004). Rice were extracted and measured by inductively coupled plasma-optical emission spectrometer (ICP-OES mod, Germany). Statistical analysis Comparison of the heavy metal content was done through SPSS software ver 11.5.

RESULTS

The results of As, Cd and Pb contents in 20 samples of polished white rice from various areas in Vahdat center (in Ghaemshahr) were (<0.005-0.051), (<0. 050-0.113) and (<0.050-0.135) mg kg^{-1} on dry wt respectively (According to the Table1-3).

Table 1: Arsenic contents in polished white rice from in Ghaemshahr (vahdat center)

	(mg kg^{-1} on dry wt)		
No	As	No	As
1	0.025	11	0.0050
2	0.020	12	0.0050
3	0.022	13	0.0050
4	0.018	14	<0.005
5	0.016	15	0.0320
6	0.017	16	0.0510
7	0.016	17	0.0170
8	0.017	18	0.0160
9	0.021	19	0.0190
10	0.005	20	<0.005

Table 2: Cadmium contents in polished white rice from in Ghaemshahr(vahdat center)

	(mg kg^{-1} on dry wt)		
No	Cd	No	Cd
1	<0.050	11	0.093
2	<0.050	12	0.090
3	<0.050	13	0.095
4	<0.050	14	0.087
5	0.0860	15	0.083
6	0.1050	16	0.103
7	0.0950	17	0.113
8	0.0960	18	0.111
9	0.0930	19	0.092
10	0.1070	20	0.086

Table 3: Lead contents in polished white rice from in Ghaemshahr (vahdat center)

	(mg kg^{-1} on dry wt)		
No	Pb	No	Pb
1	0.065	11	<0.050
2	<0.050	12	<0.050
3	<0.050	13	<0.050
4	<0.050	14	<0.050
5	<0.050	15	<0.050
6	<0.050	16	0.054
7	<0.050	17	<0.050
8	0.087	18	0.098
9	0.045	19	<0.050
10	<0.050	20	0.135

DISCUSSION

As, Cd and Pb contents in 20 samples of raw rice from various areas in the present study (in Ghaemshahr) indicated that the value of As and Cd concentration in rice were (<0.005-0.051 mgkg^{-1}on dry wt) and (<0.05-0.113 mg kgA^{-1} on dry (wt) respectively; Also Pb concentration in rice was (<0.05-0.135 mgkg^{-1} on dry wt) (According to the Table 1-3).

The food sanitary standard of Cd and Pb in rice on Standard codex/EU/WHO are 0.1-0.2 and 0.2 ppm. Cd and Pb contentsin rice are 0.1 and 0.2 ppm (mg kg^{-1}) on according to "Health and safety committees of food with high consumption" in IRAN. In all samples of raw rice, cadmium and lead contents werelowerthe maximum permitted level for rice compared with Standard codex/EU/WHO. Standard for arsenic in the raw rice has not been determined yet. Arsenic levels in the Brazilian rice samples varied from 58.8 to 216.9?ng $g^{?1}$ (0.0588 to 0.2169 mg kg^{-1}), for cadmium from 6.0 to 20.2?ng $g^{?1}$ (Batista *et al.*, 2010). In 100% samples of rice in Iran level of Pb concentration has been more than authorized level and level of Cd concentration in 88% of the samples has been more than 0.2 µg $kg^{?1}$ [16]. The studies of [17] showed that the lowest amounts of Cadmium(0.79 ppm), lead(2.67 ppm) and Arsenic in water (277.3 ppm); the lowest levels of lead(4.85 ppm) and Arsenic (105.75 ppm) in soil and the lowest amounts of heavy metals (Cd, As) in the vegetables have been Obtained [17]. The mean concentration of Pb and Cd in rice was 2.23±18 mg kg^{-1} and 0.41±0.17 dry weight, respectively (Khaniki and Zazoli, 2005a). The average concentration Compared with Japanese rice samples, the concentrations of cadmium and lead in Chinese rice samples are much lower ($p<0.05$) [18]. Results of the studies showed that level of Pb and Cd concentrations in the rice samples had been 0.2 and 0.1 mg kg^{-1}, respectively) (more than the level approved by health ministry of Iran) [19]. The average geometric of Pb in polished rice was 3-5 times more than security criteria for this type of rice (0.69 μg g^{-1}) [20]. The concentration of arsenic in soil ranged between 0.25 - 255 and 5.5 and 295 mg kg^{-1}. Arsenic concentration in plants were low for almost of the samples that indicating a low mobility of these elements in the studied soils [21]. The level of concentration of Pb and Cd in domestic wastewater-irrigated brown rice was 0.370±0.006 and 0.011±0.001 mg kg^{-1}, respectively [22]. Pb, Cd and As concentrations had been in the rice 0.5, 0.31 and 0.53 µg g^{-1} respectively in the western part of Kocani Field [23]. Results of the studies showed that the accumulation ability of rice for different heavy metals was significantly different and was in the order of Cd>Pb [3]. Distributions of Pb, Cd and Asin roots of rice plant is more than any other parts and is shown as: root>>shoot>husk>whole grain [24]. Researchers stated that fertilizers and utilization periods treatments influenced Cadmium and lead accumulation also other researchers found increases in Cadmium up take by plants as a consequence of chemical fertilizers (phosphate) utilizations [25]. The JCEFA (Joint FAO/WHO Expert Committee on Food Additives) has proposed a maximum level of 0.3 mg kg^{-1} and 0.2 mg $kg^{?1}$ lead and Cadmium in rice, respectively. JECFA has set PTWI (Provisional Tolerable Weekly Intake) for the Arsenic (Inorganic), lead and Cadmium equal to15, 25 and 7 µg kg^{-1} of body weight, respectively [26]. Average daily consumption of rice in Asian countries is 165g/person each day, (ranging from 158-178 g/person-day) [27-28].

Table 4: Descriptive Statistics

	As	Cd (mg kg^{-1})	Pb
Mean	0.0166	0.0817	0.0410
Range	0.0460	0.0640	0.0900
Minimum	0.0025	0.0250	0.0250
Maximum	0.0510	0.1130	0.1350

Table 5: Nonparametric correlations between As and Cd and Pb concentration in Rice (mg kg^{-1})

			Concentration in Rice (mg kg^{-1})		
			As	Pb	Cd
Spearman's rho	As in Rice (mg kg^{-1})	Correlation coefficient	01.0	-0.257	0.107
		Sig. (2-tailed)	00.0	00.274	0.654
		N	20.0	20.000	20.00
	Pb in Rice (mg kg^{-1})	Correlation coefficient	-0.257	10.000	0.136
		Sig. (2-tailed)	0.274	00.000	0.566
		N	20	20.000	20.00

Table 6: Intake of As, Cd and Pb via rice [(Weekly dietary intake of Cd by eating rice) (µg kg^{-1} body weight/week)]

	Item	Average	Range
	Daily rice consumption (g day^{-1})	165.000	158-17800000
As	Content (µg g^{-1})	0.0166	0.0025-0.051
	Weekly intake (µg kg^{-1} body weight/week)	0.3190	0.046-1.0590
	* Provincial tolerable weekly intake (µg kg^{-1} body weight/week)	15.000	-
Cd	Content (µg g^{-1})	0.0817	0.025-0.1130
	Weekly intake (µg kg^{-1} body weight/week)	1.5730	0.461-2.347
	Provincial tolerable weekly intake (µg kg^{-1} body weight/week)	7.0000	-
Pb	Content (µg g^{-1})	0.0417	0.0250-.1350
	Weekly intake (µg kg^{-1} body weight/week)	0.8030	0.066-2.8000
	Provincial tolerable weekly intake (µg kg^{-1} body weight/week)	25.000	-

The weekly intake of Pb and Cd from rice was 42.23 and 7.89 and µg kg^{-1} body weight/week, respectively. It was more than total level of dietary Cd and Pb intake (Khaniki and Zazoli, 2005b).

The weekly intake of As, Cd and Pb from rice was 0.319 (0.046-1.059), 0.573 (0.461-2.347) and 0.802 (0.066-2.80) µg kg^{-1} body weight/week, respectively that was lower than of total dietary As, Cd and Pb intake and that weekly As, Cd and Pb intake from rice was down the maximum weekly intake recommended by WHO/FAO (According to the Table 4 and 6). Although the negative correlation between arsenic and lead concentrations (r = -0.257) observed but this correlation is not statistically significant (p = 0.274). Also, a weak positive correlation between arsenic and cadmium (r = 0.107) observed that again not statistically significant (p = 0.654) and another weak positive correlation between cadmium and lead concentrations observed (r = 0.136) which not statistically significant (p = 0.566) (According to the Table 5).

CONCLUSION

According to results gained in this article,although density of heavy metals in rice is less than standards level. chemical fertilizers are being used more by farmers. Since pepople use various rice brands, its expected health authorities study annual level of heavy metals in exported and imported rice.

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