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Evaluation of Cadmium Residue Levels in Raw Milk from Regions of Hamedan Province in Iran, with Emphasis on Factors That Affect on the Residue of Cadmium in Raw Milk

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Abstract: Cadmium has been considered as a dangers carcinogen primarily on the basis of its induction of pulmonary tumors. Abnormally high levels of cadmium in the diet also enhance the rates of several cancers in humans. During April 2011, 48 samples of raw whole milk were collected from milk and milk product factories in different regions of the Hamadan province in western Iran and analyzed by Atomic Absorption Spectroscopy. The mean level of cadmium in the all samples were lower than the permissible level of cadmium in samples (mean = 3.21 µg/kg SD =0.81). According to the author`s preperception there were several factors which could affect the residue in raw milk. These factors can be named as the number of automobile, population and number of industrial factories. However there was no statistically significant relationship between these factors and the amount of Cadmium in the samples. The authors found out that under investigation regions which have the highest residue of Cadmium in the samples are located on the areas with the most number of metallic mines.

Key word: Heavy Metals · Residues Of Cadmium · Milk · Food Contamination

INTRODUCTION

Although the increasing development of technology lead to increase quality of life, but this has resulted in increased pollution and environmental problems [1]. Many dangerous elements or compounds, such as dioxins, pesticides, metals and metalloids, accumulate along the food chain [2]. Among the pollutants that enter the human food chain can be pointed heavy metals especially cadmium and lead that is important especially in infancy and children. Because milk and dairy products makes up an important part of human diet in many parts of the world, it has high nutritive value and consumption of these products in all ages, especially in infancy and childhood. Many reports indicate the presence of heavy metals in milk and we need to assess the levels of heavy metals in food [3-10]. Some of these studies show a relationship between industry growth, urbanization and mechanization of agricultural production in some areas with high levels of lead and cadmium residue in milk [2]. Some of researches have focused on heavy metal and their adsorption by plants and the effect of soil pH on adsorption of these elements by plants and entrance into the human food chain [11]. In this study, we detected the residue of cadmium in raw whole milks that collected from tankers arriving at processing facilities in different regions of the province Hamadan. Some of effective factors on the residue of cadmium in milk contain of the number of automobile, population, number of industrial were study.

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Table 1: The number of samples and other information about sampling

Regionsregions	Number of samples	Factories	Population	Automobiles
Asadabad	8	45	105799	7198
Toserkan	5	49	110498	8564
Malayer	10	266	289570	25880
Nahvand	8	85	160658	12567
Hamedan*	17	1022	1013064	123268

*Hamadan contains of Hamedan, Kabodarahng, Rzan, Bahar and Famenin cities

MATERIALS AND METHODS

Sampling Sites: At first with considering the ecological studies, amount of production of milk in each region and milk transferring, the Hamedan province was divided into five regional. Table 1 shows the number of samples and other information about sampling regions.

Sampling: frothy-eight 500 ml samples of raw milk were collected from tankers arriving at processing facilities in 5 areas named in Table 1. The samples were collected in sterile polyethylene containers.

Preparation of Samples: All the samples were held at 4°C and arrived at the analytical laboratory after their collection. They were held at room temperature (20°C) for 48 hours to reduce the pH bellow 4.6 and separate the casein and fat. After separation milk from serum, the samples were heated at 90°C for 5 minutes with 5 ml 65% nitric acid (Merck _ KgaA,64271, Darmstadat.Germany). Then 20 ml deionized water was added to each sample and was centrifuged for 10 minutes at 1000 rpm.

Measurement of Cadmium: In order to increase accuracy and eliminate the chemical digestion of the samples during this study, the Standard addition method was used and then the samples injected into the graphite furnace atomic absorption with Furnace Atomic Absorption (Thermo Electron Spectroscopy Ltd, Registration No. 441506 Cambridge, SOLAAR House).This method was proposed by ümit Ay & Seda Karayünlü [12].

Statistical Analysis: Kolmogorov-smirnov test shows sample data have normal distribution (p-value=0.323). We used one-way analysis of variance (ANOVA) and tukey HSD for detecting differences between regions. We consider 0.05 or significance level.

RESULTS

Table 2 shows the number of samples, mean, standard deviation and %95 confidence interval of Cadmium within regions.

The average values of cadmium residues in samples compared in Fig 2. 100% of the cadmium in the samples is below the limit value of 5 µg/kg by WHO to be announced [15].

The highest and lowest values of Cadmium mean are respectively for Toyeserkan and Hamadan regions. The ANOVA also shows that there is statistical differences between regions (P=0.007). The Tukey HSD confirmed that Cadmium in the Toyserkan region is significantly higher than Hamadan (p=0.039). However there isn't significant diffrences between each other two regions (p-value>0.05). There is no significant correlation between Cadmium and cadmium residues in raw milk and population, number of vehicles, number of industrial factories and mines in each region (p>0.5).

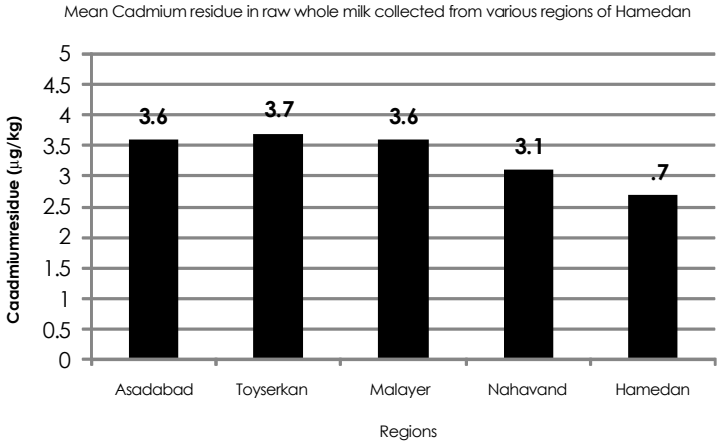

Fig. 1: Mean cadmium residue in raw whole milk collected from various regions of Hamadan

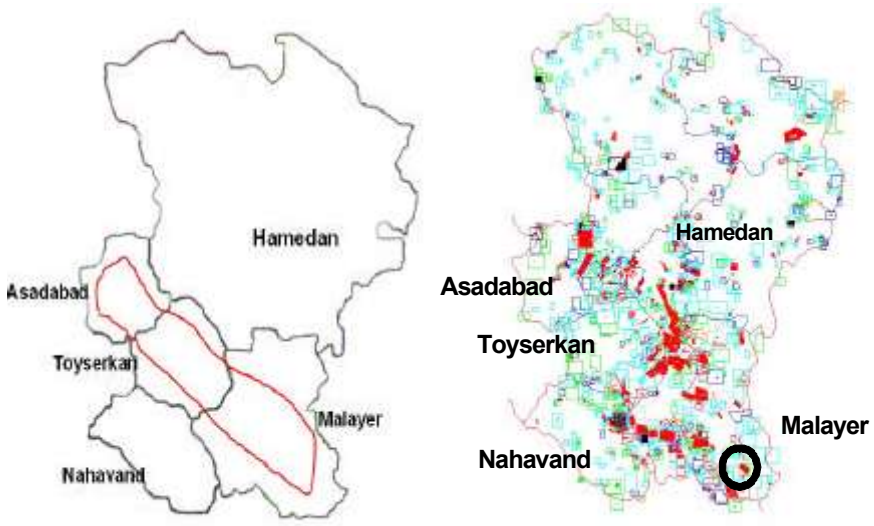

Fig. 2: a) Areas with high Cadmium levels b) Areas with high numbers of metallic mineral mining

Table 2: Cadmium residues µg/kg milk) in samples from various regions

		Cd		%95 Confidence interval	
	Number				
Regions	of samples	Mean	SD	Lower limit	Upper limit
Asadabad	8	3.6	0.89	2.84	4.34
Toserkan	5	3.7	0.38	3.24	4.21
Malayer	10	3.6	0.78	3.12	4.13
Nahvand	8	3.1	0.63	2.61	3.67
Hamedan*	17	2.7	0.72	2.33	3.08

*Hamadan contains of Hamedan, Kabodarahng, Rzan, Bahar and Famenin cities

DISCUSSION

Cadmium is widely distributed in the environment. Its extensive technological uses have resulted in widespread contamination of soil, air, water, vegetation and food supplies. Cadmium and its compounds are widely used in electroplating metals and alloys. They are also used in many industrial, household and office products and machines and in pigments in paints, enamels, glazes, textiles and plastics [16]. Cadmium is commonly found in its metallic form and as sulfides and sulfates. In foods, only inorganic cadmium salts are present. Organic cadmium compounds are very unstable. Sewage sludge, which is used as fertilize and soil conditioner, is an important source of soil pollution with cadmium. In contrast to lead and mercury ions, cadmium ions are readily absorbed by plants and are equally distributed throughout them. Cadmium exposure arises from the ambient air, drinking water, tobacco, the working environment, soil, dust and food; food is the main source of exposure to cadmium in no occupational settings [17]. Unless contamination has occurred, the levels of cadmium in most foods are normally very low. Generally, meat and seafood tend to contain higher levels of cadmium than any other food group. In 1988, the JEFCA established a PTWI of 7 µg/kg body weight for adults and infants over an accumulative period of 50 years at an exposure rate equivalent to 1µg/kg/day for adults. The WHO standard for cadmium levels in the drinking water was established at 10 µg/kg [18]. The United States has set a safety limit for drinking water and bottled water at 5 µg/kg. The intake of cadmium in the United States from 1982 to 1991 ranged from 3.7 to 14.4 µg/day [19]. The dietary intake of cadmium in several countries was estimated to be 10–80 µg/day [20]. The absorption of cadmium from food varies, depending on genetic factors, age and nutritional factors. Infants absorb and accumulate more cadmium than adults. Under normal dietary conditions, about 6% of the cadmium ingested in food and beverages is absorbed by the human body [21]. Most of the absorbed cadmium is retained in the kidneys bound to a metal-binding, high sulfhydryl protein, metallothionein. The half-life of cadmium in human kidneys may be as long as 30 years [22]. Because of cadmium's high solubility in organic acids, cadmium contamination of the human food chain is quite common. Being highly toxic, it is recognized as one of the most dangerous trace elements in food and the environment [23]. Therefore, similarly to those of lead and

mercury, cadmium levels are often monitored in the food supply. The principal long-term effects of low-level exposure to cadmium are chronic obstructive pulmonary disease and emphysema and chronic renal tubular disease. The kidney, particularly the cortex, was identified as the target organ relative to low levels of exposure to cadmium. Thus, long-term chronic ingestion of cadmium often results in serious renal damage, as well as bone disease leading to brittleness and even collapse of the skeleton [24]. Cadmium toxicity is the prime cause of itai-itai disease observed in certain population segments of Japan [25]. Exposure to dietary cadmium remains a health risk. Thus, more countries should carry out diet intake studies and appropriate measures should be taken to minimize its occurrence in the diet, especially in animal organs, shellfish, vegetables, fruits and grains from areas of known cadmium contamination. Well-designed dietary studies should be conducted in locations of potential cadmium contaminations, such as those near mining and metal extraction operations, phosphate fertilizer plants, high-cadmium- bearing strata in the soil, municipal sludge deposition areas and shellfish growing areas affected by improperly treated industrial or municipal discharges [25]. Also there is no significant correlation between the number of mines and Cadmium residues in samples, but after further investigation on the mines map in the Hamedan province we find that there is a high density of metal mining in hypothetical belt. This region includes parts of Malayer, Toyserkan and Asadabad. The geographical location of places that have high Cadmium levels residues(Malayer, Tuyserk and Asadabad) shown that these points have been located on referred belt. This similarity and compatibility is shown in Fig [2].

Further studies revealed a Lead mine located in Malayer as named Ahangaran and Malayer located in near this mine. This reinforces the hypothesis that the amount of Cadmium in soil that is high in this area can enter into farm animal's milk. In earlier studies the effect of soil composition has been proven. Even in some studies has been referred to the effect of soil pH on rate of Lead absorption [11]. Other research has proven the heavy metals including lead, cadmium and thallium uptake by the tobacco from the soil. The tobacco grown in soil containing heavy metals lead to the production of cigarettes with high levels Lead and cadmium residues. Some factors such as soil pH can influence the uptake of metals by plants [14].

CONCLUSION

It seems that vegetation and forage in these areas have absorbed the cadmium from soil and Cadmium has entered into farm animal's milk. Another hypothesis is contamination of water by passage from these regions. In this manner Cadmium has entered into water and then has entered into farm animal's milk. So more geology and soil studies in these areas is recommended.

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REFERENCES

1. Çelik, U. and J. Oehlenschläger, 2007. High contents of cadmium, lead, zinc and copper in popular fishery products sold in Turkish supermarkets. Food Control, 18(3): 258-61.
2. Tajkarimi, M., M. Ahmadi Faghih, H. Poursoltani, A. Salah Nejad, A.A. Motallebi and H. Mahdavi, 2008. Lead residue levels in raw milk from different regions of Iran. Food Control, 19(5): 495-8.
3. Harding, F., 1995. Milk quality. Springer Technology & Industrial Arts, pp: 100.
4. Jeng, S.L., S.J. Lee and S.Y. Lin, 1993. Determination of Cadmium and Lead in raw milk by garphite furnace atomic absorption spectrophotometry. J. Dairy Science, 77(4).
5. Lee, H.S., Y.H. Cho, S.O. Park, S.H. Kye, B.H. Kim and T.S. Hahm, 2006. Dietary exposure of the Korean population to arsenic, cadmium, lead and mercury. Journal of Food Composition and Analysis 19(Supplement 1): S31-S7.
6. Tripathi, M., H.P. Munot, Y. Shouche, J.M. Meyer and R. Goel, 2005. Isolation and functional characterization of siderophore-producing lead- and cadmium-resistant Pseudomonas putida. Currenty Microbiology, 50: 233-7.
7. Caggiano, R., S. Sabia, M. Emilio, M. Macchiato, A. Anastasio and M. Ragosta, 2005. Metal levels in fodder milk,dairy products and tissues sampled in ovine farms of southern Italy. Environmental Research, 99: 48-57.
8. Fayed, A.E., Z.H. Zidan, A.A.K. Abou-Arab and M.N.I. Magdoub, 1995. Ultrafiltration Membrane permeability of some milk contaminants. International Dairy J., 5: 569-76.

9. Licata, P., D. Trombetta, M. Cristani, F. Giofre, D. Martino and M. Calo, 2004. Levels of ''toxic'' and ''essential'' metals in samples of bovine milk from various dairy farms in Calabria, Italy. Environment International, 30: 1-6.
10. Raghunath, R., R.M. Ripathi, R.N. Khandekar and K.S.V. Nambi, 1997. Retention times of Pb, Cd, Cu and Zn in children's blood. Science of the Total Environment, 207: 133-9.
11. Moberg, A., G. Hallmans, R. Sjostrom and K. Wing, 1987. The effect of wheat bran on the absorption and accumulation of cadmium in rats. British J. Nutrition, 58: 383-91.
12. Ay, U., S. Karayu¨nlu, 2008. Modification in direct analysis method: metal levels in raw milk at the region of Izmit by graphite furnace atomic absorption spectrophotometer. International J. Food Science and Technology, 43: 326-9.
14. Pappas, R.S., G.M. Polzin, L. Zhang, C.H. Watson, D.C. Paschal and D.L. Shley, 2006. Cadmium, lead and thallium in mainstream tobacco smoke particulate. Food and Chemical Toxicology, 44(5): 714-23.
15. Codex Alimentarius Commission, 2010. Report of the 35th session of the Codex Committee on Food Additives and Contaminants. Arusha, Tanzania. http://www.codexalimentarius.net/download/report/47/Al0312ae.pdf.Accessed 21 sept 2010.
16. NRC, 1969. Trends in the Usage of Cadmium: A report of the National Materials Advisory Board. Publ. NMAB 255. U.S. Department of Commerce, National Technical Information Service, Springfield, Virginia.
17. IARC, 1976. Monograph on the Evaluation of Carcinogenic Risks of Chemicals to Man, Vol. 11, Cadmium, Nickel, Some Epoxides, Miscellaneous Industrial Chemicals and General Consideration of Volatile Anaesthetics. International Agency for Research on Cancer, Lyon.
18. WHO, 1963. International Standards for Drinking Waters, 2nd ed. World Health Organization, Geneva.
19. Janssen, M.M.T., 1997. Contaminants In Food Safety and Toxicity, ed. J. deVries, CRC Press, pp: 53-64.
20. Dabeka, R. and A.D. McKenzie, 1987. Dietary intakes of lead, cadmium, arsenic and fluoride by Canadian adults: A 24-hour duplicate diet study. Food Addit. Contam, 4: 89-102.
21. Reilly, C., 1991. Metal Contamination of Food, 2nd ed., Elsevier Applied Science, London, pp: 365.
22. Ahmed, F.E., 1999. Trace metal contaminants in food. In Environmental Contaminants in Food, eds. C.F. Moffat and K..J. Whittle, CRC Press, pp: 146-214.
23. Vos, G. and J.P.C. Hovens, 1987. Arsenic, cadmium, lead and mercury in meat, livers and kidneys of cattle slaughtered in the Netherlands during 1980-1985. Food Addit. Contam, 4: 73-88.
24. Frieberg, L., M. Piscator and G. Norberg, 1974. Cadmium in the Environment, 2nd ed. CRC Press, pp: 234.
25. Asami, M.O., 1984. Pollution of soils by cadmium. In Changing Metal Cycles and Human Health, ed. J.O. Nriagtu, Springer-Verlag, Berlin, pp: 95-111.