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Lead Concentrations in Raw Cows' Milk from Fars Province of Iran

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Abstract In February 2012, 96 cow milk samples were collected from different cities of Fars province and investigated using atomic absorption spectroscopy. The mean recovery of the analytical method at 10, 20, and 40 ng/ml was 85 ± 5%. Additionally, the mean level of lead content obtained from 96 samples was 10.26 ng/ml, with a range from 1.3 to 23.2 ng/ml, and a standard deviation of 4.31. Moreover, the lead concentration in 5% of the milk samples was higher than the newly established Codex standard. It is worthwhile to mention that significantly higher Pb levels were witnessed in animals aged older than 3 years ($p < 0.01$). In future studies, a greater number of milk samples added to grass samples from different animals in various regions of Fars should be analyzed to confirm the absence of heavy metals and toxicological risks.

Keywords: *heavy metals, lead, milk, fars province, atomic absorption spectroscopy*

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1. Introduction

Milk and in general dairy products contain many of essential nutrients for human body and their regular daily consumption has been widely recommended, especially for children and infants. However, another fact should be also taken into account that milk and dairy products might contain varying amounts of different toxic contaminants [1,2].

Various industrial and environmental contaminants in soil, atmosphere, waters, foods, and plants because of their toxic metals have caused their incorporation into the food chain. In particular, in the regions with metallurgical, petrochemical, and fertilizer industries, high levels of As, Cd, Cu, Hg, and Pb have been frequently observed in the air [3,4]. Added to that, fodder grown in the contaminated soils with lead accumulates this metal, and therefore, high level of contaminants has been witnessed in both fodder and soil samples at polluted regions [5,6,7]. Growing muscles and milk lead levels have been reported in lactating cows, which are reared around such industrial regions. Due to its potential toxicity and accumulation, chronic lower level intakes of lead have harmful effects on human, domestic, and wild animal health [8,9].

Milk and dairy products are amongst the important dietary components for infants and children. It is already known that their minerals and proteins are essential for the growth and health of both humans and animals. Infants and children have been shown to be more sensitive to lead contents than adults [10,11]. The regular consumption of small amounts of certain metals, such as lead, may cause different impacts on the health of growing infants and children. For instance, retardation of mental development (such as reading and learning disabilities) and deficiencies in concentration, the adverse effects on kidney function, on blood chemistry, and on the cardiovascular system, and hearing degradation [1,12]. Therefore, it is of significant importance to monitor the level of trace elements in milk and dairy products, which are accounted as the major sources of nutrition in childhood [13].

The milk from cow and goat is utilized almost entirely to produce cheese, butter, yoghurt, and some other traditional dairy products in Iran. In our searching, no data was available regarding the levels of heavy metal and trace elements contamination in milk and dairy products in Fars province. Furthermore, it should be expressed that the purpose of this study was to explore the levels of lead in cow milk samples gathered from five large cities located in different regions of Fars province, by means of atomic absorption spectrometry and using a validated method.

2. Material and Methods

2.1. Milk Sampling Method

A total of 96 raw milk samples (500 ml) were collected from 36 randomly selected cow herds in the cities of Fasa, Firouz Abad, Kazeroun, Abadeh, and Kavar, in Fars province. Table 1 exhibits the cities, randomly selected out of 29 cities in Fars province. The milk samples were

directly transferred into sterile screw-topped bottles. It is worth to state that the procedure was carried out according to the Iranian national standard method for milk sampling (i.e. INS No. 419). The samples were immediately transported to the laboratory in a cooler with ice packs and were frozen at -20°C prior to the analysis.

2.2. Trace Element Analysis

Samples were then left at room temperature (28°C) for 48 hours in order to decrease the pH (below 4.6) and separate the casein and fat. Afterwards, all samples were centrifuged at 1000 rpm for 10 minutes, the supernatant mixed with 5 ml 65% HNO_3 and heated to 90°C, after which 20 ml of de-ionized water was added. Besides, an analytical atomic absorption spectrometer (Jena model contrAA 700) was applied to measure the lead levels.

2.3. Data Analysis

Concentrations were expressed as mean ± standard deviation, and min/max values. The data was analyzed using one-way analysis of variance (ANOVA) to examine the statistical significance of differences in the mean concentration of Pb, determined in milk samples. It should be indicated that the entire calculations and statistical analyses were performed with SPSS version 16.

2.4. Quality Assurance

Appropriate quality assurance procedures and precautions were taken to ensure the reliability of the results. In addition, samples were carefully handled to avoid contamination. Moreover, the glass wares had been properly cleaned, and reagents were of analytical grades. It should be commented that deionized water was used throughout the study.

3. Results and Discussion

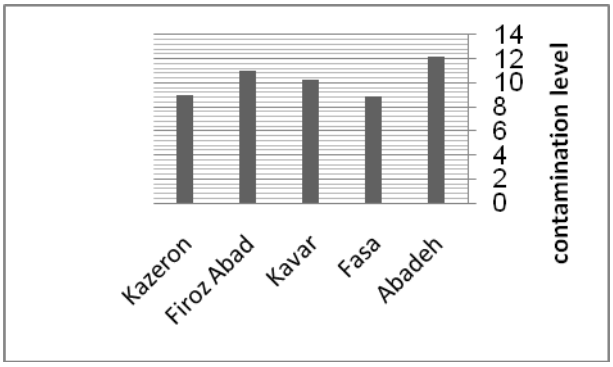

Figure 1. Mean Pb concentration per city. Kazeroun: 8.96 ng/ml; Firouz Abad: 11 ng/ml; Kavar: 10.3 ng/ml; Fasa: 8.84 ng/ml; Abadeh: 12.2 ng/ml

Figure 1 illustrates an overview of the results in addition to the comparison made amongst the concentrations measured in the cities. There were significant differences between the obtained values. The mean, and about 95% of the samples, were less than the newly established Codex standard (i.e. 20 ng/ml). However, the lead concentrations in 5% of cow milk samples were higher than the maximum permitted level in the Codex standard [14]. As exposed in Table 1, the mean concentration of lead was 10.26 ± 4.31 ng/ml (range: 1.3–23.2 ng/ml). The mean concentrations of lead in our study were lesser than the newly established Codex standard (20 ng/ml for lead). But according to the results of the current paper, the lead levels in the samples collected from two industrial cities, Abadeh and Fasa, were higher than those of other regions. In fact, the indicated regions seem to be more industrialized than others, and this issue was more apparent in Abadeh. The high levels of lead in milk might have been resulted from industrial air pollution, contaminated agricultural water for irrigation, and the use of pesticide compounds in these regions. Overall, it seems that there should be more research with regard to lead contamination sources, to control the lead residue levels in milk and other dairy products, based on the pertinent FAO/WHO guidelines.

Table 1. Lead residues (ng/L milk) in samples from various cities

City	Number of samples	Mean	Standard deviation (ng/ml)	Range (min-max) (ng/ml)
Abadeh	18	12.2	4.1	2.13-23.2
Fasa	17	8.84	3.76	1.84-21.7
Kavar	19	10.3	4.32	1.3-18.1
Firouz Abad	20	11.0	5.43	3.54-19.8
Kazeroun	22	8.96	3.98	2.65-17.8
Total	96	10.26	4.31	1.3-23.2

It is worthwhile to express that these results are similar to those achieved by Ebrahim Rahimi in 2013 years [13]. However, the mean concentrations were higher than those found in other regions of Iran, which are in the range from 1 to 46 ng/ml, with the average value of 7.9 ng/ml [15] and southern Poland (10–18 ng/ml; [16]), South Africa (8.00–19.7 µg/kgl; [1]), also were below Italy (0.2–1.19 ng/ml; [17,18]) and Spain (1.8 µg/kgl and 5.23 ng/ml; [19,20]). The previous studies suggested the importance of assessing the lead in animals reared in the vicinity of polluted areas. In fact, its presence in milk is due to various factors such as, different industrial activities, climatic factors, contaminated agricultural water for irrigation, accumulation alongside the roads and motorways, and the use of pesticide compounds [15,16,17,18].

Although, milk and milk products are not the only source of metal input in our diet, in this study we estimated the metal contribution from ingestion of milk. Food and agriculture organization of the United Nations (FAO) has established a tolerable weekly intake (TWI) of 25 µg/ kg body weight for Lead [21]. If we consider that the daily ration of milk and milk products is 200 g/day (i.e. 1400 grams per week wet weight), this would represent an intake of 1.82–32.48 µg/week of Lead. Thus, the contribution is below the TWI for an average adult of 70 kg (TWI = 1750 µg). However, it should be noticed that the lead exposure, especially for infant consumption, should be minimized as much as possible.

4. Conclusion

One of the most important sources of lead contamination in food and feed is water, especially in highly contaminated areas [14]. Therefore; water testing should be one of the critical topics for future studies in Iran. Agricultural water for irrigation should be seriously protected from sources of lead contamination and monitored for lead levels to prevent or reduce lead contamination of crops. Moreover, local and national authorities should make farmers aware of the appropriate practices for preventing lead contamination of their farmlands [22]. In conclusion, according to the findings of this paper, the current results highlighted the importance of periodically monitoring levels of heavy metals in milk and other dairy products in Iran.

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