Assessment Residues of Some Toxic Heavy Metals in Milk Marketed in Basrah Province/Iraq Using Atomic Absorption Spectrometry

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Abstract

Milk Contamination with metallic pollutants is one of the major problems in public health. Investigation of the toxic heavy metals and determining their concentrations in milk samples is important. So, this study aimed to use atomic absorption spectrometry to determine the presence of hazardous heavy metals and related human health concerns in milk sold in Basrah province. In the present study, 30 samples of liquid milk were collected from the local markets in Basrah province. Levels of heavy metals (cadmium and lead) were detected using atomic absorption spectrophotometer. The current study revealed that the mean values of cadmium and lead in the examined liquid milk were 0.054 and 0.21, respectively. The mean value of cadmium and lead metal was above the maximum limit permitted by World Health Organization /Food and Agriculture Organization (WHO/FAO) in nine and two trademarks of milk, respectively. Lead and cadmium levels were found to be above the safe limits as recommended by the WHO/FAO. In conclusion, the results suggested that cadmium and lead in milk in the investigated areas may cause disturbances and pathological conditions on several organs in the body.

Keywords: Toxic heavy metal, Liquid milk packet, Atomic absorption spectrometry

Introduction

Milk is a liquid nutrition for young mammals before they are able to digest solid food and for adults. It is rich in macro-nutrients (protein, carbohydrate, and fats) and micro-nutrient(vitamins and minerals. However, milk may contain materials with high dense, high atomic numbers and atomic weights (heavy metals) at levels harmful to public health. The most dangerous heavy metals in milk from the viewpoint of health are cadmium, lead, arsenic and mercury (1).

Heavy metals in milk come from milk containers, during milk processing, through water contamination used for agriculture, livestock feed and the environment surrounding milk-producing animals (2).

The heavy metals toxicity on human health, their sources in food, analytical methods, and heavy metals limits in milk were represented previously (3-7). The existence of heavy metal residue in milk is higher in developing countries than in developed ones. This might be related to limited inspection authorities and a lack of regular screening tests for heavy metal residues. Since becoming aware of these issues, this work aimed to detect the content of toxic heavy metals and their associated human health risks (disturbances and pathological conditions on several organs in the body) in milk marketed in Basrah province/Iraq using atomic absorption spectrometry.

Material and methods

Sample collection

A total of 30 samples (three replicates from each product) were collected from various commercial markets in Basrah city/ Iraq. These samples including products labeled as liquid milk (Almarai, King of Saudi Arabia),(Al Safi, King of Saudi Arabia), (Nada, King of Saudi Arabia), (Aklena, Turkey),(KDD, Kuwait),(Shirin Asal, Iran),(Kalleh, Iran), (Pegah, Iran), (Nan, Iraq) and (Slemani, Iraq).

Following collection, samples were kept under 4C° until analyzed. The collected samples were marked numerically (Table 1).

Table 1. Liquid milk samples that have been analyzed for the detection of heavy metal

Sample ID	Category milk	Trademark	Source
1	Liquid	Almarai	King of Saudi Arabia
2	Liquid	Al Safi	King of Saudi Arabia
3	Liquid	Nada	King of Saudi Arabia
4	Liquid	Aklena	Turkey
5	Liquid	KDD	Kuwait
6	Liquid	Shirin Asal	Iran
7	Liquid	Kalleh	Iran
8	Liquid	Pegah	Iran
9	Liquid	Nan	Iraq
10	Liquid	Slemani	Iraq

Sample Preparation for atomic absorption spectrometry

Milk sample (25 ml) was digested with H_2O_2 and HNO_3 [1:3]. The samples were then heated, diluted, and analyzed using atomic absorption spectrometery [SensAA, GBC, Germany] (8).

Preparation of standards for heavy metals

Three to five different concentrations were made to calibrate the atomic absorption spectrometry in each case of the selected metals. The absorption signals were recorded at 228.89 nm wavelength and at 217.00 nm wavelength with a silt width of 0.5 nm for cadmium and lead, respectively (8).

Estimation of daily intake of cadmium and lead through milk consumption

For risk assessment of human health, estimation daily intake(EDI) of cadmium and lead through milk consumption was calculated using the following equation (9):

$$EDI = \frac{\text{Daily mean consumption of milk (kg/day) x metal means in milk (ppm)}}{\text{Body weight of human (kg)}}$$

The adult residents in the region had an average daily intake of 200 ml of milk per day. Their body weight was set to 60 kg in the current study.

Statistical Analysis

The mean values and standard error of the heavy metals were calculated using Statistical Package for the Social Sciences (SPSS) ver. 22.0 (IBM, USA).

Results and Discussion

The current study revealed that cadmium had the highest daily intake. However, lead had the lowest risk of daily intake of heavy metals. The highest daily intake for cadmium was in the range of (0.13 to 3.6 mg/kg bw/day). However, the lowest values for lead were in range of (0 to 0.8 mg/kg bw/day). The factors contributing to daily intake of heavy metals are the quantity of milk consumption and the mean body weight (Table 2).

Table 2. Estimation daily intake of metals via consumption of milk by adult person

Sample ID	Cadmium	Lead
1	0.2	0.56
2	0.06	ND
3	0.13	ND
4	0.2	ND
5	0.2	ND
6	0.13	ND
7	0.2	ND
8	0.16	ND
9	0.2	0.8
10	0.2	ND

ND: Not-Detected

The current study revealed that the cadmium content in nine milk trademarks exceeded the respective maximum allowable concentration. The mean values of cadmium in the examined milk were detected in amounts ranging from 0.022 to 0.072 ppm(Table 3).

Table 3. Level of cadmium [ppm] in liquid milk sample with maximum allowable concentration

Sample ID	Minimum	Maximum	Range	Mean±SE	maximum allowable concentration
1	0.060	0.064	0.004	0.06±0.001	0.03[IDP,1979]
2	0.022	0.026	0.004	0.02±0.001	
3	0.041	0.045	0.004	0.04±0.001	
4	0.060	0.064	0.004	0.06±0.001	
5	0.064	0.072	0.008	0.06±0.001	
6	0.041	0.045	0.004	0.04±0.001	
7	0.060	0.068	0.008	0.06±0.002	
8	0.053	0.057	0.004	0.05±0.001	
9	0.057	0.064	0.007	0.06±0.002	
10	0.057	0.060	0.003	0.06±0.001	

Values are expressed as mean± standard error of the mean

Cadmium is a toxic heavy metal that has carcinogenic and mutagenic properties (10). The oral intake of this heavy metal from the tested different milk trademarks is high. This finding agrees with the previous study, in which the level of cadmium in liquid milk samples was mostly above the maximum allowable concentration (11). Since environmental pollution due to this metal elevates every year, contamination in the dairy industry might appear at some point. Cadmium is harmful to human health and their level in milk is prohibited or restricted by WHO/FAO. Cadmium is a metal that might pass into plants through the soil and form a part of a diet for both human and animals. The source of cadmium in the atmosphere is waste dumps or factories and smoking (12).

The present study revealed that the lead content in two milk trademarks exceeded the respective maximum allowable concentration. The mean values of lead in the examined milk were detected in amount ranging from 0 to 0.258 ppm (Table 4).

Table 4. Level of lead [ppm] in liquid milk sample with maximum allowable concentration

Sample ID	Minimum	Maximum	Range	Mean±SE	maximum allowable concentration
1	0.155	0.206	0.051	0.17±0.02	0.02[FAO/WHO,2009]
2	0.00	0.00	0.00	0.00	
3	0.00	0.00	0.00	0.00	
4	0.00	0.00	0.00	0.00	
5	0.00	0.00	0.00	0.00	
6	0.00	0.00	0.00	0.00	
7	0.00	0.00	0.00	0.00	
8	0.00	0.00	0.00	0.00	
9	0.206	0.258	0.052	0.24±0.02	
10	0.00	0.00	0.00	0.00	

Values are expressed as mean± standard error of the mean

Lead is a toxic heavy metal that has negative effects on both human nervous and cardiovascular systems (13-16). The oral intake of this heavy metal from the tested different milk trademarks is quite low. The lead level in eight milk trademarks was lower than the maximum allowable concentration. This finding disagrees with previous studies, in which the level of lead in a liquid milk sample was detected in almost the milk sample and mostly above the maximum allowable concentration (11-13). The possibility that milk exceeds the standards for indicator the maximum allowable concentration cannot be excluded. Since environmental pollution due to this metal elevates every year, contamination in the dairy industry might appear at some point. Lead is harmful to human health and their level in milk is prohibited or restricted by WHO/FAO. It is one of the heavy metals that harm the population. It enters the body through food contaminated with heavy metals. Tobacco smoking is another pollutant with a high concentration of lead. The ability of lead to block sulfhydryl groups in porphyrin synthesis is the mechanism of the toxic action of lead (12).

Conclusion

The results suggested that cadmium and lead in liquid milk backet in the investigated areas may pose a health risk to the consumer

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