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Lead in milk and milk products and its health significance in Assiut Governorate

by
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Abstract

A total of 300 samples of milk and milk products were collected from Assiut Governorate from different areas. Lead was estimated in raw milk, Ultra Heat-Treated (UHT) milk, milk powder, baby formula, Damietta and Kariesh cheese. The average levels were determined and the Estimated Weekly Intakes (EWIs) of lead were compared with the Provisional Weekly Intake (PTWI). The results revealed that there is an extensive health hazard on infants from lead through consumption of raw milk and UHT milk.

Introduction

Lead is a cumulative poison that produces a continuous effect, primarily on the haematopoietic system, the nervous system, and the kidneys. Exposure of the general population occurs by inhalation, by ingestion of food and water. Where lead pipes and lead-lined storage tanks are used, exposure from drinking water can be appreciable. In addition, children are exposed by eating non-food items (WHO, 1977). Lead causes both acute and chronic intoxication, although acute poisoning is rare, chronic poisoning is more common and serious (Gossel and Bricker, 1990).

In the last years, lead from animal food products constitutes about 8% of the total mean of dietary intake in human beings (Gracey, 1986). Lead has increased in Assiut Governorate reaching levels of 0.019, 0.24, 0.4 and 0.197 mg/L, in cow, buffaloes, sheep and goat milk, respectively, (Shehata and Saad, 1992).

Material and methods

Samples are summarized in the following table:

	Type of samples	Site of collection	Number of samples
1	Fresh milk	Assiut city	20
		Riefa village	20
		Hawatica village	30
2	Ultra heated	group (1)	15
		group (2)	15
		group (3)	10
		group (4)	10
		group (5)	10
3	Powdered milk		30
3	Infant formula		10
4	Cheese (damietta)	Assiut city	50
		Manfallout city	15
5	Cheese (Kariesh)	Assiut city	30
		Manfallout city	15
		Riefa village	20
Total			(300)

Milk and cheese samples were digested by pure nitric acid. Lead concentration of the prepared samples were determined according to the method of Campiglio (1979) using lead electrode model 94-82. The pH of the samples was adjusted to 4-7 before analysis. Lead electrode attached to an expandable ion analyzer Orion 920 Orion American Company.

Results and Discussion

Heavy metal residues, which have cumulative effect, considered a dangerous problem to the individuals especially young ages.

The obtained data of this study revealed that the average of lead in raw milk samples (Table 1) was 0.193±0.015, 0.247±0.003, and 0.343±0.032ppm in Assiut, Rifa and Hawatica cities, respectively while powdered milk and baby forms had the same level of 0.008 ±0.001-ppm.It was the lowest level. The number of samples that exceeds the maximum permissible limit (MLs) established by Egyptian legislation of 0.1 mg/kg were.12, 2, 6, 1 and 0.00 with a percentage of 60, 10, 20, 3.33, and 0.00 % in raw milk of Assiut, Rifa, and Hawatica areas, powdered milk and baby formulas, respectively.

It is clear from the obtained results that baby formulas have safe levels for infants. While powdered milk may include individual samples with higher lead levels.

The ranges of lead in the raw milk of aforementioned areas were 0.024-0.53, 0.003-2.4 and 0.001- 4 ppm, respectively. It is apparent that Hawatica raw milk contains the highest concentration followed by Rifa raw milk while Assiut raw milk had somewhat lower levels. This could be referred to the nearer location of farms of the first area to the heavy traffic. In powdered milk and baby formulas the ranges were 0.001- 0.074 and 0.002-0.019

Milk collected from cow, buffalo and goat from the area of a heavy traffic for lead had a higher range of 4.6 - 7.2 ppm in India (Bhatia and Choudhi, 1996). A lower Lead levels of 0.032, 0.049, 0.018 ppm was found in raw milk samples from industrial region followed by traffic intensive region and rural region, respectively, Simsek et al., (2000).

In previous study in Assiut Governorate the mean lead levels of 0.019±0.01 and 0.245±0.016 ppm were recorded in cow's and buffalo's milk, respectively, (Shehata and Saad 1992). After that, Salem and El-Saied (1997) found a mean level of 0.03175±0.011935 ppm with a range of 0.02-0.055 ppm in mother milk of Assiut Governorate. Later on, the mean lead values in cow and buffalo's milk in Assiut Governorate were 0.240±0.047 and 0.447±0.122 ppm (El-Prince and Sharkawy, 1999). These values are in accordance with the obtained levels in the present study.

A very low Lead concentration was (0.091 ppm) in 350 raw milk samples and 36.57% of the samples were above 0.1 ppm (Bruhn and Franke, 1976). Lead levels in milk from breast feeding mothers in an Andean Ecuadorian village ranged from 0.0014 to 0.039 ppm (Counter et al., 2000). The mean value of lead in milk samples from dairies in Styria, Austria was 0.00 24 ppm (Kofer et al, 1987). These levels are far lower than that of our obtained results. In the same time, the mean lead level in urban samples in Malaysia, was 0.0253 ug/ml, which is significantly higher than the Malaysian rural samples (0.0211 ug/ml).

The provisional weekly intake of lead in food must be not exceeding more than 0.005-mg/kg bw/week as recommended by FAO/WHO (1989). However, Carl, (1991) postulated that the acceptable limits ranged from 0.05 to 0.2 ppm. The acceptable level of lead in milk was set in Britain at 0.04 mg / L (Humphreys, 1991).

The Joint Expert Committee on Food Additives JECFA established a Provisional Tolerable Weekly Intake (PTWI) for lead of 50 ug/kg of body weight, applicable to adults only (WHO, 1972). Because of the special concern for infants and children, JECFA evaluated in 1986 the health risks of lead to this population group and established a PTWI of 25 ug/kg of body weight (GEMS/Food, 1988). Infants and children are more vulnerable to exposure to lead than adults because of metabolic and behavioral differences, (WHO, 1977).

Relatively few countries report dietary intake of lead by infants and children. Since the PTWI of lead for infants and young children refers to the maximum intake from all sources of ingestion, the median/mean intakes should be well below 25 ug/kg body weight, because they may ingest lead from dust or soil by hand to mouth activities. A reduction in lead intake by infants and children apparently occurred in USA, similar to the decreased previously noted PTWI for adults intake. GEMS/Food data from Australia and Ireland on levels of lead in infant foods show such decreasing trend, with levels below 50ug/kg being achieved in recent years. Lead intake by infants and children is far in excess of the PTWI of 25ug/kg body weight in areas where tap water contains elevated lead levels (GEMS/Food, 1988).

Considering an infant consumes an average of 120 ml milk/kg b.w. /day and an adult, weighing 60 kg, consumes 120 ml per day, the Estimated Weekly Intake (ýEWI) in this study (Table 1) reached 6.7-ug/kg bw/week. Powdered or baby formulas it is considered safe levels, while in fresh milk of the mentioned areas (Assiut, Rifa and Hawatica), the values were 162, 207 and 288-ug/kg bw./week, respectively. The PTWI of milk is 25 ug/kg bw./week according to (GEMS/Food,1988). The EWI from this study are more than 5 to12 times the PTWI of fresh milk. This reflects the danger on consuming of infants to such raw milk. The values in powdered milk and baby formulas are far lower than the (PTWI).

The present study revealed variable levels of lead in the examined five (UHT) milk origins. The levels are shown in Table (2). Lead levels reached 0.289±0.02, 0.18±0.017, 0.6±0.038, 0.095±0.00and 0.009±0.001 ppm in the five analyzed groups. The overall range varies from 0.001 to

1.1 ppm. The percent of samples that exceeded the maximum permissible limit were 53.3, 53.3, 90, 0.0 and 0.0 % in the five groups, respectively.

The increased levels in the three of five UHT milk sources (group1, 2, and 3) indicate the exposure of such sources to pollution or contamination. The use of recycled water could be suggested to be the main source of lead pollution in their corresponding farms.

The estimated weekly intake (Table 2) of the (UHT) when mainly consumed by infants is 242.7, 151.2, 534.2, 79.8 and 7.5 ug/kg bw/week from the five types of (UHT) milk. In the other hand the (EWI) of adults are 4.044, 2.52, 8.90, 1.33 and 0.126. These levels are far lower than the (PTWI) which is 50 ug/kg bw/week.

The daily lead intake (EDI) of an infant during his first year of life in the German Democratic Republic ranged from 42 - 47 ug of lead. A conversion to mg/kg of body weight shows that, the load of lead on an infant equals that on an adult or is even greater. (Woggon and Jehle 1976)

Lead levels in different types of cheese in different localities are illustrated in (Table 3). The present data revealed that Damietta cheese had average levels of 0.115±0.008 and 0.212±0.007 ppm from Manfalute and Assiut areas, respectively. While in Kariesh type the average reached 0.036±0.002, 0.29±0.023 and 0.293±0.027 ppm in Manfalute, Assiut and Rifa areas. The overall range varies from 0.001 to 6.0 ppm.

Our present results are in accordance with that of Zaky et al., (1995) who recorded a mean lead level in some kinds of cheese in Assiut Governorate as 0.28±0.01-mg/kg dry weight. While in Kareish cheese it was found to contain the highest average of lead 0.55±0.03 mg/kg while Damietta had an average of 0.25±0.018 ppm.

The percentage of samples that exceeded the maximum permissible limit (0.1 ppm) according to the Egyptian Standards (1993) are 42, 46.6, 6.6, 35 and 23.3 % in Damietta cheese of Assiut, and Manfalute areas and

Kariesh cheese of Manfalute, Rifa and Assiut areas, respectively. These percentages of samples reflect an indion consuming the individual cheeses containing more than the (MLS). The Kariesh cheese from Assiut had near three times the recommended level while Assiut Damietta and Manfalute Damietta had double this value.

The estimation of the weekly Intake (EWI) by a person weighing 60 kg and consumes 200 g daily of cheese are 4.49, 2.681, 0.84, 6.836 and 6.766 ug/kg b.w. / week from the previous mentioned types of cheese.

The (EWIs) are considered far low (about one tenth) from the (PTWI) which is considered as (50ug/kg bw/week).

In a previous survey the average values of lead for Ricolta cheese of Mount Etna Volcano, Sicily were 9.2 ug/kg, respectively. (Cimino et al., 1991). Mean lead content determined in nationally representative samples of cheese consumed in Finland was 0.017 ppm in Finnish cheese and 0.017-0.060 ppm in imported cheese (Tahvonen and Kumpulainen, 1995). Dabeka and Mckenzie (1995) found that lead levels in the examined cheese averaged 0.0146 ppm.

Higher levels of lead in the examined milk and cheese samples may be attributed to heavy automobile traffic using leaded gasoline in addition to the use of lead water pipelines in these areas. Attention must be paid to the reused purified waters in crop cultivation that essential for feeding of dairy cattle. These present results emphasize the importance of warning about the hazardous effects of this pollutant on infants and growing children and in the same time the newly born animals. Studies involving the repeated estimation of lead in milk and milk products must be conducted regularly to recognize its possible health hazardous effects. As bioaccumulation of lead during chronic exposure and its mobilization and secretion in milk constitute a serious health hazard to the newly born children, the results of this research point out the necessity for undertaking preventive measures and continuing the research on a larger scale on lead contents in infants and growing children to evaluate the expected risk due to lead exposure and to take the measures to treat and remove the expected increased amounts from their blood..

REFERENCES

Bhatia I, and Choudhri GN (1996): Lead poisoning of milk--the basic need for the foundation of human civilization. Indian J Public Health Jan-Mar;40(1):24-6

Bruhn, J.C. and Franke, A.A. (1976): Lead and cadmium in California raw milk. J Dairy Sci. Oct.;59(10):1711-7

Campiglio, A. (1979): Potentiometric microdetermination of lead electrode and its application of organic lead compound. Microchim.Acta,1, 267.

Carl, M. (1991): Heavy metals and other trace elements. Monograph on residues and contaminants in milk in milk and milk products. Chapter 6 . International Dairy federation, Belgium.

Cimino, G.; Leuzzi, U.; Salvo, F and Ziino, M. (1991) : Heavy metal pollution. Part xi: impact of the volcanic activity on etnean milk and ricotta. Rivista-della-societa Italiana, di-scienza-dell Alimentazione, 20: 6, 365 - .

Counter, S.A., Buchanan, L.H., Ortega, F., Amarasiriwardina C, Hu H (2000): Environmental lead contamination and pediatric lead intoxication in an Andean Ecuadorian village. Int. J. Occup Environ Health Jul-Sep;(3):169-76.

Dabeka, R.W. and McKenzie, A.D. (1987): Lead, cadmium, and fluoride levels in market milk and infant formulas in Canada. J Assoc Off Anal Chem Jul-Aug;70(4):754-7

Egyptian Standard Regulation (1993): Maximum level for heavy metal contaminant in foods, Egyptian Organization for Standardization ES No. 2360.

El-Prince, E. and Sharkawy, A.A. (1999): Estimation of some heavy metals in bovine milk in Assiut Governorate. Assiut Vet. Med. J., Vol. 41, No. 81: 153-169.

FAO/WHO joint Expert Committee on food additives (WHO) Technical Report series No. 505 (1972): No:555(1974), No. 751(1987) and No. 776(1989). Evaluation of certain food additives and contaminants. Geneva.

GEMS/Food (1988): Assessment of chemical contaminants in food: Report on the results of the UNEP/FAO/WHO program on the health-related environmental monitoring (UNEP/ MARC- London, UK).

Gossel, A.T. and Bricker, J. D. (1990): Metals. In Principals of Clinical Toxicology. 2nd edition. pp 162-192. Ravan Press, New York.

Gracey, J.F. (1986): Chemical residues in meat. In: Meat Hygiene. 8th ed., English language Book Society/Bailliere Tindall. pp. 191-210.

Humphreys, D.J. (1991): Effects of exposure to excessive quantities of lead on animals. British Vet. J. 147: 18-30.

Klaassen, C.D. (1985): Heavy metals and heavy metal antagonists. In Pharmacological basis of theraputics, (A. J. Gilman, L.S. Goodman, T.W. Rall and F. Murads, Eds), 7th ed., pp. 1605-1627, Macmillan, New York.

Kofer, J.; Golles, J.; Lichtenegger, F. and Schnidler, E. (1987): Surveillance studies on heavy metals in bulk milk in styria. Wiener. Tierarztliche-Monatsschrift., 74: 12, 412-416.

Salem, D.A. and El-Saied, M.M. (1997): Levels of organochlorine pesticides, lead and cadmium in mothers milk and infants dietary intake in middle Egypt. J. Egypt. Soc. Toxicol. Vol. 18:65-71.

Shehata, A. and Nagah, M. Saad (1992): Lead content in milk of lactating animals at Assiut Governorate. Assiut Vet. Med. J. 26 (52) 135-141.

Simsek, O., Gultekin, R., Oksuz, O. and Kurultay, S. (2000): The effect of environmental pollution on the heavy metal content of raw milk. Nahrung Oct.; 44(5): 360-3

Tahvonen, R. and Kumpulainen J. (1995): Lead and cadmium contents in milk, cheese and eggs on the Finnish market. : Food Addit Contam Nov-Dec; 12 (6):789-98

WHO (1972): Evaluation of certain food additives and the contaminants. Mercury, lead and cadmium. Tech. Rep. Ser. No. 505. WHO, Geneva, Switzerland.

WHO (1977): Environmental Health Criteria No. 3. Lead, Geneva

Woggon, H. and Jehle, D. (1976): Land cadmium content of baby food and their nutritional hygienic-toxicological significance: Nahrung; 20(8-9):807-15.

Zaky, Z.M.; Sabreen, M.S.; Abulfadl A., M. and Salem, D.A. (1995): Lead, iron, copper, zinc, manganese and cadmium level in some foodstuffs of animal origin. Cheese and Luncheon. 3rd Cong. Toxicol. Dev. Count., Cairo, , 19-23 Nov., Proceedings, Vol. III, pp. 201-212 (Sept. 1996).

Table 1- Lead levels (mg/l) in different types of milk in different localities.

Origin	Fresh mi			Powdered milk	Baby forms
	Assiut	Rifa	Hawatica		
Average±S.E	0.193±0.015	0.247±0.003	0.343±0.032	0.008±0.001	0.008±0.001
Range	0.024-.53	0.003-2.4	0.001-4.0	0.001-0.074	0.002-0.019
No. > Mls	12	2	6	1	00
Percentage	60	10	20	3.33	00
Median	0.13	0.004	0.001	0.005	0.0065
EWI (ug/kg b.w./week)	162(I) 2.702(a)	207(I) 3.458(a)	288(I) 4.802(a)	6.7(I) 0.0186(a)	6.7(I) 0.0186(a)
PTWI (ug/kg b.w./week) (GEMS/Food, 1990)	25(I) 50(a)	25(I) 50(a)	25(I) 50(a)	25(I) 50(a)	25(I) 50(a)

Table 2-Lead levels (mg/l) in some UHT milk milk .

Origin	Group(1)	Group (2)	Group (3)	Group (4)	Group (5)
Average±S.E	0.289±0.020	0.18±0.017	0.636±0.038	0.095±0.005	0.009±0.001
Range	0.0025-1.1	0.001-0.96	0.02-1.1	0.0017-0.019	0.004-0.019
No more than Mls	8	8	9	00	00
Percentage	53.3	53.3	90	00	00
Median	0.23	0.12	0.51	0.012	0.008
EWI (ug/kg b.w./week)	242.7(I) 4.044(a)	151.2(I) 2.52(a)	534.2(I) 8.904(a)	79.8(I) 1.33(a)	7.5(I) 0.126(a)
PTWI (ug/kg b.w./week) (GEMS/Food, 1990)	25(I) 50(a)	25(I) 50(a)	25(I) 50(a)	25(I) 50(a)	25(I) 50(a)

(I): Infant , (a): Adult
ADI: Acceptable Daily Intake.
EDI: Estimated Daily Intake.
PTWI: Provisional Tolerable Weekly Intake.
EWI: Estimated weekly intake.
MLs : Maximum permissible limit

Table 3- Lead levels (mg/l) in different types of cheese in different localities

Origin	Assiut damietta cheese	Manfalute damietta cheese	Manfalute kariesh cheese	Rifah kariesh cheese	Assiut kariesh cheese
Average±S.E	0.212±0.007	0.115±0.008	0.036±0.002	0.293±0.027	0.29±0.023
Range	0.005-2.1	0.002-0.52	0.011-0.13	0.005-1.8	0.001-6.0
No > Mls (0.1mg/l)	21	7	1	7	7
Percentage	42	46.6	6.6	35	23.3
Median	0.0655	0.081	0.025	0.05	0.014
EWI (ug/kg b.w./week)	4.94(a)	2.681(a)	0.84(a)	6.836(a)	6.766(a)
PTWI (ug/kg b.w./week) (GEMS/Food, 1990)	50	50	50	50	50