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A Review:

Lead content in milk and milk product

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INTRODUCTION

There is a steady increase in the processing of all types of heavy metals in industry and the household. Therefore, proper disposal, recycling and the regulation of the application of sewage to agricultural land have assumed great importance.

According to their nutritional role, the metals from food products can be divided in two categories: essential metals (*e.g.* Na, K, Ca, Cu, Zn, and Mn) and unessential metals (like Pb, Hg, Al, Sn, and Ag). For both categories, increasing of metal concentration in food over the limits can cause toxic effects for consumers of these products.

Lead is naturally present in normally all components of the environment and man takes lead from the air as well as food and drink. Increasing attention has been given in the recent years by the health authorities and public in general to the risk connected with contamination of the environment with heavy metals. Special attention has naturally been given to the content of the toxic trace elements in food.

Human exposure to lead comes from the main sources: using leaded gasoline, using lead-based paints, having lead pipes in water supply systems and exposure to industrial sources from processes such as lead mining, smelting and coal combustion. Additional sources of lead include soldered seams in food cans, ceramic glazes, batteries and cosmetics.

According to Ellen (1995) approximately 90 per cent of all lead emissions into the atmosphere are due to the use of leaded gasoline (Magda, 1996). Battery recycling is also an important source of lead exposure on a global scale, 63 per cent of all processed lead is used in the manufacturing of batteries. Lead-glazed pottery and lead pigments in children's toys and pencils are other routes of exposure. Lead solder in aluminium cans also pose significant risks. Lead can enter up in water and soils through corrosion of leaded pipelines in a water transporting system and through corrosion of leaded paints. It cannot to broken down; it can only converted to other forms.

Lead content in milk:

The concentration of lead in milk is a matter of special concern because milk is a major dietary constituent for infants. Extensive surveys have been made on lead concentrations in milk.

Walker (1980) determined the mean Pb contents in evaporated milk, homogenized cows' milk, dried skim milk and in human milk collected from Washington DC. (Data is presented in Table 1). Rodriguez *et al.* (1999) determined the concentration of Pb and Cd in samples of human, raw and pasteurized cow and goat milk and dried infant formula. (Data is summarized in Table 1 and 2) and they concluded that the concentration of Pb in different milk did not present any risk to human health.

Mean Pb in milk of 92 Bulgarian Simmental (BS); 92 BS x Ayrshire and 84 Black Pied cows during 1 year was 0.332 to 0.441; 0.348 to 0.453 and 0.369 to 0.533 mg/kg, respectively (Petrakiev *et al.*, 1983). Orlando *et al.* (1998) determined the contents of Pb and other heavy metals in cow milk and dried milk and they observed that the contents of Pb were below the detection limit for cow milk. Cerkvenik *et al.* (2000) examined the residues of trace elements in 188 samples of raw cow milk from 19 dairy locations (in Slovenia) during 1994 to 1998 and they reported that the Pb contents in all samples corresponded to tolerance level (0.1 mg/kg) and 98 % of these samples <0.05 mg/kg.

Mean concentration of Pb in milk in cows with clinical and subclinical mastitis was 0.35 ± 0.03 or 0.42 ± 0.04 ppm (Ram Naresh *et al.*, 1999) Imparato *et al.* (1999) found that the cow milk was of good quality with low levels of contamination of Pb, while studying the Pb and Cd contents in 234 samples of cow milk from dairy farms in the Avellino region, Campania, Italy. Milk from 30-38 Peking Black Pied cows which were in the first 4 months of $2^{nd} – 4^{th}$ lactation contained Pb – 0.009 ± 0.0046 ppm (Wun *et al.*, 1981)

Vega *et al.* (1977) observed that the lead contents in 20 tins of protein-enriched and 20 vitamin-enriched evaporated milk was 38.4 ± 11.4 and 35.0 ± 4.5 mug/100

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Table 1: Content of lead in various milk

Sr. No.	Type of Samples	No. of Samples	Content	Country	Reference
1.	Human milk	40	0.02 m u g/ml	U.S.A.	Walker (1980)
2.	Human milk	156	26 µg/kg	Poland	Juszkiewicz *et al.* (1983)
3.	Human milk	-	12.0 ng/g	Pakistan	Khalid *et al.* (1987)
4.	Human milk in 1st month of lactation	89	0-270 µg/lit	-	Mitrovic *et al.* (1992)
5.	Human milk	-	50 ng/g	-	Baranowska (1994)
6.	Human milk	55	8.34 (0.1-32.3) µg/litre	-	Rodriguel *et al.* (1999)
7.	Human milk	55	8.34 µg/lit (0.1-32.3)	-	Rodriguez *et al.* (1999)
8.	Cow milk	376	25 µg/kg	Poland	Juszkiewicz *et al.* (1983)
9.	Cow milk	13	0.020 $\pm$ 0.019 ppm	-	Barrado *et al.* (1989)
10.	Cow milk	140	8.52 $\pm$ 1.64 ng/ml	Turkey	Aktan *et al.* (1991)
11.	Raw cow milk	11	20-130 µg/lit	-	Mitrovic *et al.* (1992)
12.	Cow milk	-	0.012 – 0.036	Czech. Farms	Citek *et al.* (1994)
13.	Cow milk	20	0.0349 ppm	-	Murta *et al.* (1995)
14.	Cow	52	24.6 ng/ml (0.0-106.0),	Argentina	Rubio *et al.* (1998)
15.	Raw cow milk	28	14.82 (1.3-39.1) µg/litre	-	Rodriguez *et al.* (1999)
16.	Raw cow milk	28	14.82 µg/lit (1.3-39.1)	-	Rodriguez *et al.* (1999)
17.	Cow milk (Rural area)	16	0.24 $\pm$ 0.03 mg/kg	India	Swarup *et al.* (1997)
18.	Cow milk (Urban area)	36	0.32 $\pm$ 0.04 mg/kg	India	Swarup *et al.* (1997)
19.	Homogenized cows' milk	10	0.01 m u g/ml	U.S.A.	Walker (1980)
20.	Goat milk	31	0.035 ppm	Austrilia	Mitcheli *et al.* (1981)
21.	Goat milk	36	11.86 µg/lit (0.4-38.5)	-	Rodriguez *et al.* (1999)
22.	Goat milk	36	11.86 (0.4-38.5) µg/litre	-	Rodriguez *et al.* (1999)
23.	Sub urban buffalos' milk	-	117 ng/g	Pakistan	Khalid *et al.* (1987)
24.	Urban buffalos' milk	-	238 ng/g	Pakistan	Khalid *et al.* (1987)
25.	Pasteurized cow milk	15	25-220 µg/lit	-	Mitrovic *et al.* (1992)
26.	Pasteurized cow milk	6	10.25 µg/lit (6.9-19.6)	-	Rodriguez *et al.* (1999)
27.	Pasteurized cow milk	6	10.25 (6.9-19.6) µg/litre	-	Rodriguez *et al.* (1999)
28.	Milk	6	0.06 mg/kg	Japan	Nakazawa *et al.* (1980)
29.	Milk	4	27.5 µg/kg	-	Favretto and Marletta (1984)
30.	Milk	73	0.06 ppm	-	Kaise *et al.* (1985)
31.	Milk	154	0.045 mg/kg	Poland	Gorska and Litwinczuk (1996)
32.	Milk	52	24.6 ng/ml (0.0-106.0)	Argentina	Rubio *et al.* (1998)
33.	Milk	103	0.96 µg/lit	-	Litwinczuk *et al.* (1999)
34.	Bulk milk	18	< 0.01 mg/kg	Large Swiss dairies	Wenk *et al.* (1995)
35.	Bulk milk	103	0.96 µg/lit	-	Litwinczuk *et al.* (1999)
36.	Cultured	5	4.694 ppm	Egypt	Ayoub *et al.* (1994)
37.	Cultured milk	5	4.694 ppm	Egypt	Ayoub *et al.* (1994)
38.	Condensed milk	-	863 ng/g	Pakistan	Khalid *et al.* (1987)
39.	Condensed milk	5	11.071 ppm	Egypt	Ayoub *et al.* (1994)
40.	Condensed milk	5	11.071 ppm	Egypt	Ayoub *et al.* (1994)
41.	Dried milk	16	Trace	-	Kaise T *et al.* (1985)
42.	Dried milk	-	0.069 to 1.109 mg/kg	Poland	Bulinski *et al.* (1992)
43.	Dried milk	5	8.133 ppm	Egypt	Ayoub *et al.* (1994)
44.	Dried milk	5	8.133 ppm	Egypt	Ayoub *et al.* (1994)
45.	Dried Skim milk	10	0.53 m u g/g	U.S.A.	Walker (1980)
46.	Dried whole milk	-	1.496 ppm	-	Tseng (1985)
47.	Dried whole milk	-	179 (15-320) ng/g	Pakistan	Khalid *et al.* (1987)

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Table continue …………………

48.	Evaporated milk	10	0.30 m u g/ml	U.S.A.	Walker (1980)
49.	Evaporated milk	1422	0.09 oom	-	Jelinek (1982)
50.	Skim milk	8	15.70 µg/kg	-	Marletta and Favretto (1983)
51.	Pasteurized milk	5	1.501 ppm (mg/kg)	Egypt	Ayoub *et al.* (1994)
52.	Pasteurized	5	1.501 ppm	Egypt	Ayoub *et al.* (1994)
53.	Sterilized	5	1.087 ppm	Egypt	Ayoub *et al.* (1994)
54.	Sterilized milk	5	1.087 ppm	Egypt	Ayoub *et al.* (1994)
55.	Whole milk	60	0.02 ppm	-	Jelinek (1982)
56.	Whole milk	8	17.58 µg/kg	-	Marletta and Favretto (1983)
57.	Market pasteurized milk	-	0.121 ppm	-	Tseng (1985)
58.	Dried flavoured milk	-	0.815 ppm	-	Tseng (1985)
59.	Flavoured	-	0.055 ppm	-	Tseng (1985)
60.	Fermented milk	-	0.042 ppm	-	Tseng (1985)
61.	Market milk	-	19.5 ng/g	Pakistan	Khalid *et al.* (1987)
62.	Adapted milk	23	45-220 µg/lit	-	Mitrovic *et al.* (1992)
63.	Low fat milk	-	1.7 µg/kg	Finland	Tahvonen B-Kumpulainer *et al.* (1995)

ml., respectively. Pilsbacher *et al.* (2001) found that no single sample was tested positive for Pb while studying the Pb and Cd contents and aflatoxin M1 and organochlorine pesticides, polychlorinated biphenyls in Austrian raw milks during 1996-2000. Pilsbacher and Grubhofer (2002) while working on Hg, Cd and Pb in Austrian raw milk, concluded that Austrian raw milk was only contaminated to a small extent and that these metals only had a very low contribution on the cumulative milk contamination. Saleh *et al.* (1996) studied the levels of lead in human milk of 120 Egyptian women representing 20 different governorates throughout Egypt using graphite furnace Atomic Absorption Spectrophotometry.

Concentrations of the potentially toxic elements; Pb and Cd and other essential elements, in different milk samples and baby food materials were measured by Tripathi *et al.* (1999), primarily to assess whether the intakes comply with recommended desired levels for essential and permissible levels for toxic elements. The geometric mean concentrations of Pb in different types of milk were found to vary from 1.70 to 3.35 µg/l, while the same in different baby foods had values from 39.5 to 77.7 µg/kg. The lead content in cow milk was observed to be the lowest even in comparison with breast milk. The infant baby food Amul Spray contains low concentrations of toxic (Pb and Cd) elements. The daily intakes of Pb, Cd, Cu and Zn by infants through milk and baby foods marketed in Mumbai city have also been estimated. The daily intakes of Pb (1.1 µg/kg) for infants through baby foods are well below the recommended tolerable levels of 3.57 µg/kg. The Data are presented in Table 1.

Lead content in milk products :

Fouzy (2000) while studying the trace element contents including Pb in 36 samples of Domiati cheese and 36 samples of butter collected from Egypt, observed that the Pb content was within the permissible limit. In controversy, El-Kenary *et al.* (2001) studied the levels of heavy metals including Pb in white cheese samples collected from the Egyptian market and picklings and they found that the Pb contents were in higher concentrations than the IDF values and they also reported that over 60 % reduction was found in Al, Cr, Pb and Zn contents of cheese after 90 days of picklings. Similar results were found by Omaima (1999) in 20 Kareish cheese samples collected from Cairo city while studying the level of trace elements including Pb, he reported that that the Pb levels were higher than FAO/WHO acceptable dietary intakes. (Data presented in Table 2). Ayoub *et al.* (1994) analyzed the milk products of Egypt for Pb, Cd and Hg using AAS and they concluded that the Pb, Hg and Cd in different milk products act as a serious health hazard for humans and animals consuming such products. (Data are presented in Table 2).

Galeno (1986)determined the trace element contents including Pb in 9 different commercial milks and in raw milk using AAS in Turin and he reported that the contents of 3 toxic elements, Hg, Pb and Cd were low (< 5 mg/ kg). While, Zawadzka and Mazur (1985) analyzed the metal contents including Pb in a large number of Polish, food samples including ice cream and evaporated milk

Table 2 : Lead content in milk products and infant formula

Sr. No.	Type of Samples	No. of samples	Content	Country	Reference
1.	Butter	6	0.361 ppm	-	Kaise *et al.* (1985)
2.	Cream	8	29.44 µg/kg	-	Marletta and Favretto (1983)
3.	Mozzarella cheese	4	100 µg/kg	-	Favretto and Marletta (1984)
4.	Cheese	30	0.42 ppm	-	Kaise *et al.* (1985)
6.	Finish cheese	-	17 µg/kg	Finland	Tahvonen and Kumpulainen (1995)
7.	Kareish cheese	20	0.122 µg/g	Egypt	Omaima *et al.* (1999)
8.	Cream	4	0.06 ppm	-	Kaise *et al.* (1985)
9.	Infant formula	110 samples of 11 National brand	0.05-0.50 mug/ml	U.S.A.	Walker (1980)
10.	Infant formula	-	183 (22-230) ng/g	Pakistan	Khalid *et al.* (1987)
11.	Infant formula	5	8.30 (5.1-10.6) µg/litre	-	Rodriguez *et al.* (1999)
12.	Infant formula	5	8.30 µg/lit (5.1-10.6)	-	Rodriguez *et al.* (1999)
13.	Infant formula	9	0.085 $\pm$ 0.086 ppm	-	Barrado *et al.* (1989)
14.	Dried infant formula	-	0.883 ppm	-	Tseng (1985)
15.	Yoghurt	13	0.03 ppm	-	Kaise *et al.* (1985)
16.	Whey	4	19.7 µg/kg	-	Favretto and Marletta (1984)
17.	Other milk products	11	Trace	-	Kaise *et al.* (1985)
18.	Milk powder	107	2.03 ng/ml, (0.98 to 4.45)	-	Jeng *et al.* (1994)

and they found that the metal contents were within the permissible range. Dabeka (1984) determined the Pb contents of 3 infant formulae and 1 evaporated milk samples, (all stored in lead – soldered cans) by 9 laboratories using a rapid graphite furnace AAS method and he reported that the Pb contents ranged from 29 to 200 ng/g. The corresponding data of lead in milk products are presented in Table 2.

Conclusion :

All this has taken place against the background of a steady increase in the processing of all types of heavy metals in industry and the household. Most of the lead contamination in milk could happen due to feeding the cows with fodder collected from along the roadsides and can be controlled by choosing the source of the fodder without lead contamination. The concentration of heavy metals and trace elements in fresh milk are relatively constant and only exceptionally increase when animals consume feed from contaminated area.

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