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PUBLIC HEALTH HAZARD OF HEAVY METALS IN SOME CANNED DAIRY PRODUCTS

A. S. Aiad and A. H. Fayed

Animal health research institute (Alexandria)

ABSTRACT

A total of 60 random samples (20 each of milk- based infant formula, milk powder, and condensed milk) were randomly collected from different localities in Alexandria Governorate. The collected samples were analyzed for the levels of lead, cadmium, copper and zinc by using Atomic absorption spectrophotometer. Results revealed that the mean lead levels in the examined milk- based infant formula; milk powder and condensed milk were 0.44 ± 0.093, 0.23 ± 0.038 and 0.12 ± 0.013 ppm, respectively. The mean cadmium levels in the examined samples were 0.031 ± 0.005, 0.11 ± 0.027, and 0.032 ± 0.005 ppm, respectively. The mean copper levels in the examined samples were 0.86 ± 0.094, 0.21 ± 0.024, and 0.053 ± 0.003 ppm, respectively. While, the mean zinc levels in the examined samples were 0.59 ± 0.019, 0.49 ± 0.014 and 0.19 ± 0.007 ppm respectively. This study pointed to protect human and animal from excessive intake of heavy metals.

INTRODUCTION

Environmental pollution with heavy metals leads to growing interest in metal contamination of milk and milk products which represent an important part in human diet especially for children. Heavy metals represent one of the most important groups of pollutants in food supply (**Protasowicki, 1992**). The amount of different heavy metals has been increased with the development of human civilization, an additional concern about their concentration in domestic and industrial waste products. Also, heavy metals may contaminate food by a leaching process between the food and it's containers (**Hagsted and Hubbert 1986**).

The toxic elements which are considered of major interest in dairy products include lead and cadmium. These metals of recognized toxicity and their presence in food at significant concentration is a potential health hazard (**Baum and Shannon, 1997**).

Lead is one of the most important pollutants in our environment which accumulates in the body due to its low rate of elimination; its biological half life in bone is about 27 years (**Shibamo-**

to and Bjelanès 1993). Chronic lead poisoning is characterized by neurological effects including encephalopathy and peripheral neuropathy. It is also affects renal tissues producing acute and chronic nephropathy as well as hypertension and liver dysfunction. A strict correlation has found between chronic exposure to low lead doses and neuropsychological impairment in first childhood was often reported (**Guldi et al., 1996**).

Cadmium and its salts are widely employed in numerous industrial processing. It is a component of many commercial products and found in nature in close association with lead and Zinc (**klaassen, 1985**). Cadmium is known to induce chronic renal disease (**Madden and Flower, 2000**). It is also a potent pulmonary carcinogen and play significant role as a cause of hypertension and osteomalacia (**Friberg et al., 1986**) also it is major contributor to thyroid disease (**Watanabe et al., 2000**).

Zinc and copper are widely distributed in nature and essential component of several enzymes. Each essential metal has three levels of biological activity, trace level required for optimum growth and development, storage level and toxic level. These elements are tranlocated through the food chain to man and animal (**Pound, 1975 and Pope, 1975**).

Copper is important in formation of erythrocytes, development of bone, central nervous system and connective tissue. Both excess and deficiency of copper in mammalian system result in serious effects (**Hostynek et al 1993**). Abnormal high liver copper level lead to various disease including cirrhosis, Mediterranean anemia, haemochromolosis, yellow atrophy of liver and Wilson's disease (**Underwood, 1977**).

High level of zinc in foods may be toxic to the human body, where it causes deficiencies in other metals like copper (**Kula and Lasto, 1986**). Toxicity by zinc leads to tremors, central nervous system depression, bloody diarrhea and intense abdominal pain (**Gasarett and Doulls, 1996**).

Since heavy metals can not be destroyed or broken over long time by heat treatment or environmental degradation and they are persistent type of pollutants and translocated through food chain to man and animal (**Huang et al., 2003**).

Therefore the aim of the present work is to investigate the environmental pollution with some heavy metals especially lead, cadmium, copper and zinc in milk- based infant formula, milk powder and condensed milk and to suggest a protocol for prevention of this pollution in Alexandria Governorate.

MATERIALS AND METHODS

1. Collection of samples:-

A total of sixty representative samples of canned milk- based infant formula; milk powder and condensed milk (20 samples of each) were randomly collected from different markets in Alexandria city then transferred to laboratory for estimation of lead, cadmium, copper and zinc.

2. Digestion of samples:-

The collected samples were prepared and digested according to AOAC (1980), **Richerd and RubinShapiro (1986) and Khan et al., (1995)**.

3. Estimation of metals:-

Lead, cadmium, copper and zinc were determined by using Atomic absorption spectrophotometer (PERKIN, ELMER 2380), according to **Agemain et al., (1980)** and **kairtyahnn et al., (1982)**.

RESULT AND DISCUSSION

Heavy metals are considered the main contaminants causing serious health hazard to human and animal population through progressive irreversible accumulation in their bodies as a result of repeated consumption of small amount of these elements (**Wheaton and lawson, 1985**).

1. Lead:

Lead is considered one of the most hazardous pollutants to animal and human beings health status, as it is a threat to man via food and drink or inhalation. The presence of lead in the human food chain continues to be a major health problem world wide.

The obtained results revealed that the mean concentration of lead in examined milk- based infant formula were 0.44 ± 0.093ppm. (Table 1 & Fig.1).

Guidi et al., (1996) estimated lead content in milk -based infant formula and found that the mean lead level was 73-139.11 mg / kg. The author hoped milk formula industry to have a more specific control on lead milk content for children feeding.

Egyptian organization for standardization (**EOS**, 1993) reported that the maximum permissible limit of lead in milk- based infant formula must be not more than 0.1 ppm. In present study 95 % of milk- based infant formula samples were exceeded the maximum permissible limit (MPL) of lead. (Table 2 & Fig. 2). On the other hand higher results were reported by **EL -Aglzy (2005)**. While, lower results were obtained by **EL- Malt (2001)**.

The mean concentration of lead in milk powder samples were 0.23 ± 0.038 ppm (Table1& Fig.1). **(EOS, 1993)** reported that the maximum permissible limit of lead in milk powder must be not more than 0.5 ppm. 25 % of milk powder samples were exceeded the maximum permissible limit (MPL) of lead (Table2 & Fig.2). Higher results were obtained by **Mansour (1999)**, while lower results were obtained by **Fayed (2001)**. The mean concentration of lead in examined condensed milk samples were 0.12 ± 0.013ppm (Table 1 & Fig. 1). The maximum permissible limit of lead in condensed milk samples must be not more than 0.2 ppm **(IDF 1979)**. All condensed milk samples were complied with the allowable permissible limit (MPL.) of lead for human consumption (Table 2 & Fig. 2). Higher results in condensed milk were obtained by **Mansour (1999)**.

The present study revealed a highly significant elevation in lead content of examined milk-based infant formula and milk powder collected from Alexandrina. **WHO (1982)** Reported that the major source of lead in the environment resulting from manufacture and application of alkyl fuel additives.

2. Cadmium:

Cadmium and its salts are widely employed in numerous industrial processing. It's a component of many commercial products and found in nature in close association with lead and zinc **(Klaassen, 1985)**. Also it is a toxic metal can cause abroad spectrum toxicological and biological dysfunction **(Funakoshi et al. 1995)**. Cadmium accumulates with the age in body tissue and cause renal failure **(Friberg et al., 1986)**. And it has a significant role in the incidence of many other diseases such as diabetes mellitus and hypertension **(Nishiyama et al.,1986)**.

The mean cadmium levels in examined milk- based infant formula samples were 0.031 ± 0.005ppm (Table1 & Fig.1). The maximum permissible limit of cadmium in milk-based infant formula was 0.05 ppm **(EOS, 1993)**. 50 % of milk- based infant formula were exceeded the MPL (Table 2). Higher results in milk-based infant formula were obtained by **El-Aglzy (2005)**. Lower results were obtained by **(EL-Malt 2001)**.

The mean cadmium levels in examined milk powder samples were 0.11 ± 0.027ppm (Table1 & Fig.1). The maximum permissible limits of cadmium in milk powder must be not more than 0.005 according to **IDF (1979)**. All of milk powder samples were exceeded the MPL (Table2 & Fig.2). Lower results in milk powder were reported by **Fayed (2001)**. While, higher results obtained by **Mansour (1999)**. The mean cadmium level in examined condensed milk samples were 0.032 ± 0.005 ppm (Table1 & Fig.1). The maximum permissible limit of cadmium in condensed milk samples must be not more than 0.005 ppm (**IDF, 1979**). All the condensed milk samples were exceeded the maximum permissible limits (Table 2 & Fig. 2). Lower results in condensed milk were obtained by (**Mansour 1999**).

(**Eklund and Oskarssan 1999**) examined 59 baby food samples in Sweden and found that the mean cadmium levels ranged from 1.10 to 23.5 ppm.

3. Copper:

Copper is an essential element for human and animals and act as a cofactor for several enzyme systems including cytochrome- oxidase and tyrosinase. Excess amount of copper in food give rise to outbreaks of copper poisoning.

Table (1) & Fig (1) showed that the mean concentration of copper in examined milk- based infant formula was 0.86 ± 0.094 ppm. **EOS (1993)** reported that the maximum permissible limit of copper in milk- based infant formula must be not more than 5 ppm. All examined milk- based infant formula samples were complied with MPL (Table 2 & Fig. 2). Lower results in milk-based infant formula were reported by **Amer et al., (2006)** while, higher results (45.01mg/kg) were obtained by **Ayoub (2002)**. The high level of copper in examined milk based infant formula may be due to the wide application of copper in agriculture and industry as fungicides and insecticides.

The obtained results revealed that the mean concentration of copper in examined milk powder samples was 0.21 ± 0.024 ppm. All examined milk powder samples complied with MPL (5 ppm) **EOS (1993)**. Higher results in milk powder were reported by **Fayed (2001)** while lower results were reported by **El-Agizy (2005)**.

The mean concentration of copper in examined condensed milk samples was 0.053 ± 0.003 ppm (Table1 & Fig.1). The maximum permissible limit of copper in condensed milk must be not more than 0.3 ppm. (**Under wood, 1977**). All examined condensed milk samples were complied with MPL (Table 2 & Fig. 2). Higher results in condensed milk were obtained by **Mansour (1999)**.

Copper is essential element at low concentration but it is toxic at high levels. The daily intake requirements of copper are 30 μg / kg body weight for an adult male, with larger amounts of 40 μg / kg for older children and 80 μg / kg for infants (**WHO 1973**). Ingestion of an excessive dose of copper may lead to sever nausea, bloody diarrhea, hypertension and jaundice; however, copper poisoning is characterized by kaser-fleischer ring which is a golden brown ring of accumulated copper on the cornea of the eye. (**Gossel and Bricker, 1990**) .

4. Zinc:

The wide use of zinc in the home and else where in the community accounts for a very high level of zinc contamination encountered in dust, water and atmosphere causing poisoning. In the absence of an adequate dietary supply of zinc, serious and characteristic deficiency symptoms arise **(Reilly, 1991)**. Table (1) & Fig (1) showed that the mean value of zinc in examined milk-based infant formula samples was 0.59 ± 0.019 ppm. The maximum permissible limit of zinc in milk- based infant formula must be not more than 5 ppm **(Ding et al., 1993)**. All examined milk- based infant formula samples comply with the MPL. Higher results in milk-based infant formula was obtained by **Amer et al. (2006)**. The mean level of zinc in examined milk powder was 0.49 ± 0.014 ppm. The maximum permissible limit of zinc in milk powder samples was 40 ppm **(Bulinski, 1992)**. All milk powder samples comply with MPL. Higher results in milk powder were reported by **Fayed (2001)**. The mean level of zinc in examined condensed milk samples was 0.19 ± 0.007 ppm. All examined condensed milk samples comply with MPL which is 40 ppm. **(Bulinski et al., 1992)**. Higher results in condensed milk were obtained by **Mansour (1999)**.

Excessive zinc intake displaces copper as well as iron and interferes with copper incorporating iron in the prophoryn compounds; hence anemia develops **(Golden and Golden 1981)**. Accidental oral zinc poisoning has been reported in human as a result of consuming acidic food from galvanized containers. The symptoms of such intoxication consist of fever, vomiting, stomach cramps and diarrhea **(Schraoder and Balassa, 1967)**. Zinc is abundant in tab water than surface water due to it is leaching from galvanized pipes and brass **(Nariagu, 1980)**.

High zinc to copper ratio may result in interference with lipid metabolism. The imbalances of the dietary zinc-copper intake have been associated with hypercholesterolemia **(Klevag, 1975)**.

To minimize the health risk of heavy metals we recommended that the following measures must be put in consideration to minimize the sources of heavy metals contamination in milk and milk products through encouragement of the use of unleaded benzene; application of good agricultural and industrial practices; control use of pesticides and fungicides. Milk producers and distributors should have enough information about the danger of heavy metals in dairy products on public health and from the economic point of view. The dairy products should be produced under the modern quality assurance system by application of hazard analysis critical control points (HACCP) to ensure quality and safety of these products.

Table (1): Lead, cadmium, copper and zinc levels (ppm) in examined canned dairy products.

Product	Lead	Cadmium	Copper	Zinc
	Mean ± SEM (ppm)			
Milk-based infant formula	0.44 ± 0.093	0.031 ± 0.005	0.86 ± 0.094	0.59 ± 0.019
Milk Powder	0.23 ± 0.038	0.11 ± 0.027	0.21 ± 0.024	0.49 ± 0.014
Condensed Milk	0.12 ± 0.013	0.032 ± 0.005	0.053 ± 0.003	0.19 ± 0.007

Table (2): Number and percent of examined canned dairy products samples above maximum permissible limits.

Product	Lead			Cadmium			Copper			Zinc		
	MPL	Samples above MPL		MPL	Samples above MPL		MPL	Samples above MPL		MPL	Samples above MPL	
		No	%		No	%		No	%		No	%
Milk-based infant formula	0.1	19	95	0.05	10	50	5	0	0	5	0	0
Milk Powder	0.5	5	25	0.005	20	100	5	0	0	40	0	0
Condensed Milk	0.2	0	0	0.005	20	100	0.3	0	0	40	0	0

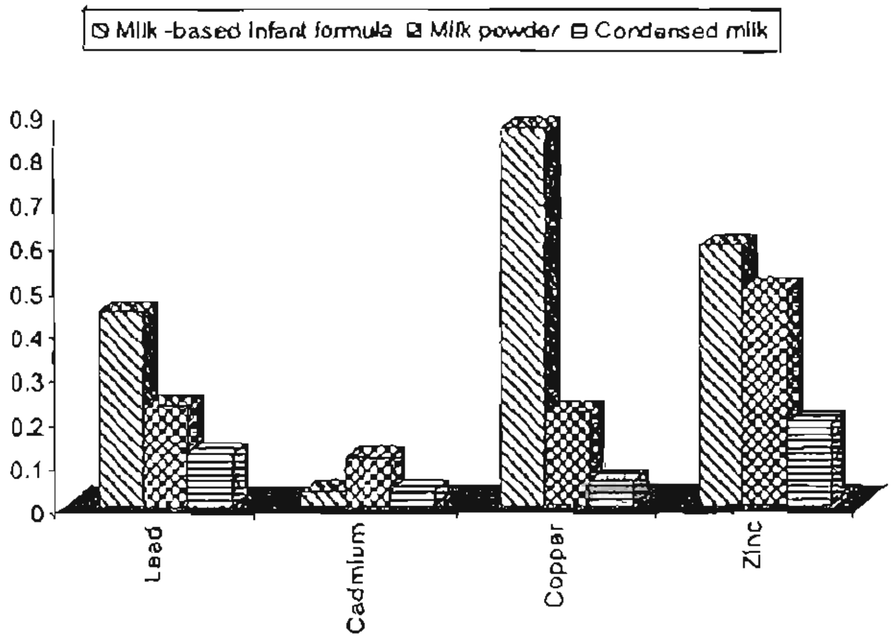

Fig. (1): Levels of Lead. Cadmium. Copper and Zinc in examined canned dairy products (*ppm*).

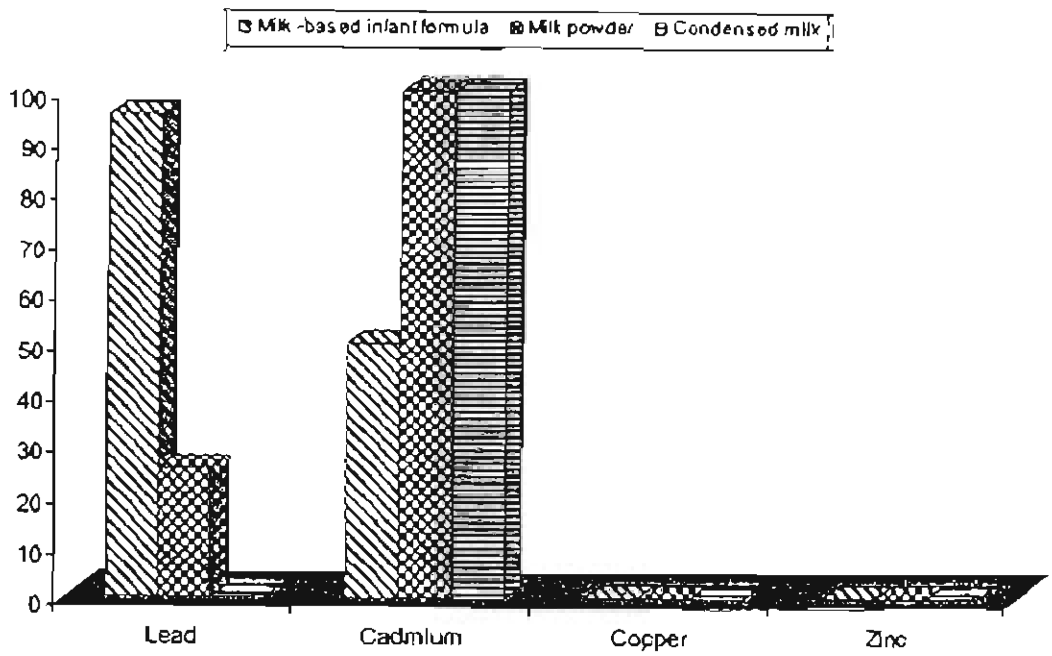

Fig. (2): Percent of examined samples canned dairy products above MPL.

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الملخص العربى

الخطورة الصحية للمعادن الثقيلة فى بعض منتجات الألبان المعلبة

أحمد صلاح الدين عياد　　　　أحمد حسن فايد*

معهد بحوث صحة الحيوان - معمل فحوص الأغذية جمرك الإسكندرية

معهد بحوث صحة الحيوان - معمل الإسكندرية*

أصبحت مشكلة تلوث البيئة قضية خطيرة تشغل العالم البرم وكذلك القائمين على صحة الإنسان، لأن التلوث إمتد ليشمل الماء والهواء، والتربة ومايخرج منها من نبات يتغذى عليه الإنسان والحيوان وقد نجم عن هذا أضرار بالغة الخطورة لحقت بالإنسان والحيوان نتيجة تناول هذه الأغذية الملوثة، ونظراً للقيمة الغذائية العالية لمنتجات الألبان المختلفة وكذلك لأهميتها الصحية للإنسان وبخاصة الأطفال عن طريق مايمكن أن تحمله من الملوثات الكيميائية خاصة العناصر الثقيلة والتى زاد إنتشارها فى البيئة على نطاق واسع، لذلك كان من الضرورى دراسة تركيز العناصر الثقيلة بمنتجات الألبان المختلفة للحفاظ على جودة هذه المنتجات ولحماية المستهلك بمايتفق مع المواصفات القياسية العالمية والمحلية، ولقد أجريت هذه الدراسة على عدد ٦٠ عينة عشوائية من منتجات الألبان المعلبة (٢٠ عينة من كل من ألبان الأطفال ولبن البودرة واللبن المكثف المركز) تم تجميعها من أماكن مختلفة من محافظة الإسكندرية وبعد تجهيزها وهضمها تم فحصها باستخدام جهاز الامتصاص الذرى الطيفى وذلك لتقدير بقايا المعادن الثقيلة بها ومقارنة النتائج بالحدود المسموح بها، ولقد أسفرت النتائج عن تواجد الرصاص فى عينات ألبان الأطفال، لبن البودرة، واللبن المكثف المركز بمتوسط قدرة ٤٤ر٠، ٢٣ر٠، ٣٢٠ر٠، جزء فى المليون على التوالى وتواجد الكادميوم فى هذه المنتجات على التوالى هو ٣١٠ر٠، ١١ر٠، ٠٢٢ر٠ جزء فى المليون، ومتوسط تركيز النحاس هو ٨٦ر٠، ٢١ر٠، ٠٥٣ر٠ جزء فى المليون على التوالى، وقد اتضح من تحليل العينات إحصائيات إن معدلات تركيز الرصاص تجاوزت الحدود المسموح بها فى ٩٥٪، ٧٥٪ من العينات فى لبن الأطفال ولبن البودرة على التوالى بينما كانت فى الحدود المسموح بها فى اللبن المركز المكثف، وكانت نسبة العينات التى تجاوزت الحدود المسموح بها بالنسبة للكادميوم هى ٣٠٪، ٥٥٪، ١٠٠٪ فى لبن الأطفال، لبن البودرة، واللبن المركز المكثف على التوالى، وكان معدل تواجد عنصرى النحاس والزنك فى الحدود المسموح بها فى كل العينات، وقد تم مناقشة النتائج وخطورة تواجد هذه المعادن على الصحة العامة للإنسان وكذلك الاحتياطات اللازمة لتجنب هذه المخاطر.