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EVALUATION OF SOME HEAVY METAL RESIDUES IN WHOLE MILK POWDER USED AT CONFECTIONERY PLANTS REGARDING THEIR PUBLIC HEALTH SIGNIFICANCE

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SUMMARY

The preliminary study was conducted to evaluate some heavy metal residues in whole milk powder which used at confectionery plants. Twenty random samples were collected from different plants at Damietta City. The collected samples were analyzed for determination of lead; cadmium; mercury; tin; copper and zinc by Perkin Elmer Atomic Absorption Spectrophotometer. Results obtained revealed that mean values of lead; cadmium and mercury were exceeded the permissible limits. While tin; copper and zinc were below the permissible limits. The public health significance of the obtained results was declared.

INTRODUCTION

Heavy metals are persistent as contaminants in the environment and come to the fore front of dangerous substances causing healthy hazard in human. Lead, cadmium, mercury and tin are among the most important of these elements. Industrial and agricultural processes have resulted in an increased concentration of heavy metals in air, water, soil and subsequently, these metals are taken by plants or animals and take their ways into food chain (**Ahmad, 2002**).

The presence of heavy metals in dairy products may be attributed to contamination of the original cow's milk, which may be due to exposure of lactating cow to environmental pollution or consumption of feeding stuffs and water (**Carl, 1991**) and (**Okada et al., 1997**). Moreover, raw milk may be exposed to contamination during its manufacture (**Ukhun et al., 1990**) and (**El-Batanouni** & **Abo El- Ata, 1996**).

Contamination of milk powder with heavy metals may cause a serious risk for human health because of the consumption of even small amount of metals can lead to considerable concentrations in human body, metals that can not metabolized as cadmium; lead and mercury persist in the body and exert their toxic effect by combination with one or more reactive groups essential for normal physiological function and cellular disturbances or clinical manifestation may be appear (**Friberg** & **Elinder, 1988**) and (**Skerfving, 1988**). The adverse toxic effect caused by lead (**Subramanian, 1988**);

cadmium (**Friberg et al., 1986**); mercury (**Manahan, 1989**) and tin (**Reilly, 1991**) are widely recognized.

In spite of the hazard effects of heavy metals on public health, some of them are essential for normal physiological functions such as copper and zinc (**Zaki, 1988**) and (**Hays, 1989**) also, copper sulphate exhibit clear reduction of cadmium residues in animal tissues (**Ahmed et al., 1999**), the dietary deficiencies of copper; zinc; calcium; iron; protein and an excess dietary fat cause an increase in the absorption and toxicity of lead (**Goldfrank et al. 1990**).

MATERIAL AND METHODS

Sampling:

A total of twenty random samples of whole milk powder were collected from some confectionery plants at Damietta City, the samples collected from its original packages in an clean polyethylene bags, labeled and taken to the laboratory then kept in refrigeration till analysis.

Preparation:

A measured weight 5gm of each sample was transferred into clean and acid washed screw-capped digestion tubes.

Digestion procedures:

Procedures A: Each prepared sample was digested according to **Tsoumbaris** & **Papadopoulou** (**1994**). All samples were analyzed by using flame atomic absorption spectrophotometer (AAS) for determination of lead (Pb); cadmium (Cd); copper (Cu); and zinc (Zn). On the other hand, tin (Sn) was detected by using flameless AAS.

Procedures B: For determination of mercury (Hg) in whole milk powder samples the procedures carried out according to **Gomez** & **Mar kaki** (**1974**). All samples were analyzed by flameless AAS.

Analysis on Atomic Absorption Spectrophotometer:

All filtrated samples were analyzed for their contents according to **Medina et al.** (**1986**) by using "*Perkin Elmer Atomic Absorption Spectrophotometer model 2380 equipped with Mercury Hydride System (MHS), USA 1988*".

Quantitative determination of heavy metals in examined whole milk powder samples:

Concentrations of Pb; Cd; Hg; Sn; Cu; and Zn in examined samples were calculated according to the following equation:-
Mg/kg in examined samples = $A \times B/W$
A= mg/kg of metal in prepared samples (obtained by calibration).
B= final volume of prepared sample in ml.
W= weight of samples in grams.

Statistical analysis: Maximum; minimum; mean and standard error were calculated according to **Petrie** & **Watson** (**1999**).

RESULTS AND DISCUSSION

Table (1): Heavy metal concentration in whole milk powder samples (n=20).

Metal	No. of positive samples	Min.	Max.	Mean ± S.E.	Permissible limit mg/kg
Pb (ppm)	20	2.11	3.99	2.55 ± 0.12	0.3*
Cd (ppm)	20	0.12	o.86	0.41 ± 0.05	0.05*
Hg (ppb)	20	0.08	0.12	0.10 ± 0.00	0.02*
Sc (ppm)	20	3.21	4.86	3.62 ± 0.11	50.0*
Cu (ppm)	20	0.016	0.25	0.110 ± 0.002	0.4**
Zn (ppm)	20	2.770	4.822	3.661 ± 0.113	5.0**

* Egyptian Standards No. 2360 (1993) and No. 1648 milk powder (2001).
** Citek et al. (1996).

Regarding to results in Table (1) the average of lead concentration in examined whole milk powder samples was 2.55 with a minimum of 2.11 and a maximum 3.99 ppm. These result is nearly similar to those reported by **Finoli** & **Roundinini** (**1989**); **Bulinski et al.** (**1993**) and **Hamouda** (**2002**). While lower finding was reported by **Cabrera et al.** (**1995**).

Concerning to results in Table (1) the mean cadmium concentration in examined whole milk powder samples was 0.41 with values ranged from 0.12 to 0.86 ppm., lower findings were recorded by **Morrison** (**1988**); **Finoli** & **Roundinini** (**1989**); **Ukhun et al.** (**1990**) and **Bulinski et al.** (**1993**).

Mercury concentration tabulated in Table (1) was ranged from 0.08 to 0.12 with a mean value of 0.10 ppb., in examined whole milk powder samples. Nearly similar result was reported by **Hamouda** (**2002**). While, higher concentrations were obtained by **Gomez** & **Mar kaki** (**1974**) and **Morrison** (**1988**).

Recorded data in Table (1) indicated that tin concentration was detected in examined whole milk powder samples with an average of 3.62 ppm., slightly higher findings were recorded by **Morrison** (**1988**) and **Hamouda** (**2002**). While, lower tin concentration was reported by **Jiraskova** & **Srna** (**1983**).

As indicated by data in Table (1) the mean concentration of copper was 0.110 ppm., this result goes hand in hand with those reported by **Favretto** & **Marletta** (**1984**) and **Garcia et al.** (**1999**). While , zinc mean concentration that showed in the same table was 3.661 ppm., nearly similar result was recorded by **Gartrell et al.** (**1986**). Meanwhile, higher result was recorded by **Mazzotta et al.** (**1993**), whereas lower finding was revealed by **Garcia et al.** (**1999**).

It was concluded from the obtained results that most examined whole milk powder samples having lead; cadmium and mercury residues above the permissible limits recommended by **Egyptian Standards** (**1993** & **2001**). On contrary, tin was below the permissible limits recommended by **Egyptian Standards** (**1993** & **2001**), otherwise for each copper and zinc were below the permissible limits recommended by (**Citek et al., 1996**).

General speaking, this study demonstrates that the imported whole milk powder were polluted with some heavy metal residues specially lead; cadmium and mercury.

From the public health point of view lead (Pd), toxicity caused renal tubular dysfunction indicated by proteinuria, aminoaciduria, glucosuria, hyperphosphaturia and impairment of sodium transport **Jones** & **Hunt** (**1983**); **Goyer** (**1986**) and **Manahan** (**1992**), also, has multiple hematological effects causing shortening life-span of circulating erythrocytes while, inhibit hemoglobin synthesis and cause fragile red blood cells which result in anemia **Paglia et al.** (**1975**); **Nordberg** (**1976**); **Jones** & **Hunt** (**1983**); **Rubin** & **Farber** (**1988**) and **Hays** (**1989**). Clinically lead toxicity have been associated with sterility casing gametotoxicity effects in both male and female **Stowe** & **Goyer** (**1971**) and **Ibels** & **Pollack** (**1986**), reduction in sperm counts, abnormal sperm motility and morphology **Assenato et al**. (**1986**) and **Goldfrank et al.** (**1990**). CNS is the target of lead toxicity in children while in the adults the peripheral system is affected **Rubin** & **Farber** (**1988**); **Reddy** & **Hayes** (**1989**); **CDC** (**1991**); **Haschek** & **Rousseaux** (**1991**) and **Shibamoto** & **Bjeldanes** (**1993**). In addition, gastrointestinal problems are associated to lead exposure **Cooper** & **Gaffey** (**1975)**; **Hernberg (1975)**; **USEPA** (**1986**); **Goldfrank et al.** (**1990**) and **Gossel** & **Bricker** (**1990**). As cardiovascular collapse leading to death **Gossel** & **Bricker** (**1990**).

Cadmium (Cd), is cumulative toxic agent with biological half-life of several years and their burden of the body increase with age. Moreover, it is added that Cd is deposited mainly in liver and kidneys; **Friberg et al.** (**1974**); **Suzuki et al.** (**1979**); **Donaldson** (**1980**); **WHO** (**1980**); **Suzuki** (**1982**); **Jin et al.** (**1987**); **Goyer et al.** (**1989**); **Gossel** & **Bricker** (**1990**); **Manahan** (**1992**); **Ibraheem** (**1996**); and **Harbison** (**1998**). also, Cd one of hypertension causes **Thind** & **Fischer** (**1976**) and **Shibamoto** & **Bjeldanes** (**1993**). In addition, is teratogenic and carcinogenic agent **CIPAC** (**1979**) and **Shibamoto** & **Bjeldanes** (**1993**) and pulmonary impairment **CIPAC** (**1979**) and **Friberg et al.** (**1986**). Also, alteration in different blood parameters as percentage of lymphocytes and lactate dehydrogenase **Guilhermino et al.** (**1998**).

Mercury (Hg), the most toxic of all mercurial is methylmercury as the irreversible CNS damage **Mclntrye** (**1971**); **Koss** & **Longo** (**1976**); **Marsh et al.** (**1981**); **Goldfrank et al.** (**1990**) and **Jensen** (**1995**) have been responsible for kidney impairments **Tubbs et al.** (**1982**); **Chey et al.** (**1989**) and **Reddy** & **Hayes** (**1989**) and postnatal poisoning via breast milk with infant symptoms are similar to those in adult **Grandjean et al.** (**1994**).

Tin (Sn), in foods appears to be poorly absorbed and is excreted mainly in feces and small amount absorbed may be retained in kidney, liver, and bone **WHO** (**1973**) high level of tin in food can cause acute poisoning manifested in growth retardation , anemia due to influence hemoglobin formation **Reilly** (**1991**) and cause renal failure **Nuyts et al.** (**1995**) and cause hepatic necrosis **Harbison** (**1997**).

Abnormal accumulation of copper (Cu) in the tissues and blood is a point of similarity with genetic disease of man called Wilson’s disease **Jones** & **Hunt** (**1983**) and **Lee** and

Garvey (**1998**). Most absorbed Cu is stored in liver and bone marrow where it is bound to metallothionein **Sarkar et al.** (**1983**), the acute exposure to Cu result in nausea, vomiting, bloody diarrhea, hypertension, uremia and cardiovascular collapse **Gossel** & **Bricker** (**1990**).

Chronic ingestion of excess supplemental zinc (Zn) can produce anemia and leucopenia consequent to induced copper deficiency **Hoffman et al.** (**1988**). Zinc toxicity in humans from excessive dietary ingestion is uncommon, but gastrointestinal distress and diarrhea have been reported **Reddy** & **Hayes** (**1989**); **Walshe et al.** (**1994**); **Casarett** & **Doull's** (**1996**) and **Goyer** (**1996**).

Finally, metals can directly and indirectly damage DNA and that means an increase risk of cancer this called genotoxicity. There also, possibly non-genotoxic pathway, due to irritation or immuno-toxicity **CIPAC** (**1979**).

CONCLUTION

It can be concluded from the present investigation that analysis of whole milk powder at some confectionery plants indicates their contamination by some heavy metals residues, exhibiting a wide array of hazardous impacts on human health. These are mainly due to greater pollution of the environment, air, water and soil and subsequently, these metals are taken by plants and animals and take their ways into milk, in addition heavy metals may reach to milk and milk products during the production and processing.

The fact that all metals are toxic and our bodies require special transport and handling mechanisms to keep them from harming us. This applied just as essential minerals like iron; zinc and chromium, as it dose to non-essential metals and metalloids like cadmium and arsenical compounds.

In order to minimize the hazardous effect of this pollutants and to protect the human health, strict and regular monitoring of heavy metal residues of imported milk and milk products at different ports and that above the permissible limits should be refused and return to the original exported countries.

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