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LEAD, CADMIUM AND MERCURY IN MILK PRODUCTS

(With One Table)

By

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الرصاص والكادميوم والزئبق فى منتجات الألبان

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أجرى هذا البحث لتحديد مستوى الرصاص والكادميوم والزئبق فى بعض منتجات الألبـــــان (اللبن المبستر والمعقم والمتخمر والمركز والبودره) - تم تجميع العينات عشوائيًا من بعض المناطق بمدينة الزقازيق - محافظة الشرقيه وتجهيزها للقياس بواسطة جهاز الامتصاص الذرى الطيفى - وقد أسفر تحليل العينات عن تواجد الرصاص فى اللبن المبستر والمعقم والمتخمر والمركز والبودره بمتوسط قدره ٥٠١ ر ١ ، ٨٧٠ ر ١ ، ٦٩٤ ر ٤ ، ٧١٠ ر ١١ ، ١٣٣ ر ٨ جزء فى المليـــــون (مجم / كجم) على التوالى . أيضًا وجد أن متوسط الكادميوم فى نفس هذه العينات هو ٠٣٨ ر ، ٦٠٠ ر - ، ٢١٨ ر - ، ٤٣٨ ر - ، ٠٩١ ر - ، ٥٥٦ ر - جزء فى المليون (مجم / كجم) على التوالى . وقد لوحظ عدم تواجد الزئبق فى اللبن المتخمر والمركز . وقد أظهرت النتائج تواجد الرصاص والكادميوم والزئبق بتركيزات أعلى من الحدود المسموح بها فى اللبن ومنتجاته . وقد أشارت النتائج أن تواجد هذه المعادن الثقيله فى منتجات الألبان بتركيزات مرتفعه له أضرار صحيه بالغه على صحة الانسان والحيوان المستهلك لهذه المنتجات .

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SUMMARY

A total of 25 random samples of dairy products including pasteurized, sterilized, fermented condensed and powdered milk (five sample each), were collected from different localities in Zagazig City, Sharkia Governorate. The samples were analyzed for detection of lead, cadminum and mercury using Atomic Absorption Spectrophotometer. The average of lead in pasteurized, sterilized fermented, condensed and powdered milk were 1.501, 1.087, 4.694, 11.071 and 8.133 ppm, (mg/kg) respectively. On the other hand, the mean values of cadmium in the same products were 0.038, 0.060, 0.218, 0.438 and 0.04 ppm (mg/kg), respectivley. Meanwhile, the average of mercury in pasteurized, sterilized and powdered milk were 0.086, 0.091 and 0.556 ppm (mg/kg), respectively. The mercury could not be detected in fermented and condensed milk. The analysed samples contained lead, cadmium and mercury above the Permissible limits. The obtained results indicated that the lead, cadmium and mercury in different milk products act as a serious health hazard for man and animal consuming such products. Therefore, a regular monitoring of heavy metal contamination of milk and milk products is recommended to establish the true contribution of milk and milk products to the dietary intake of heavy metals.

INTRODUCTION

Contamination of milk and milk products by chemical pollutants is one of the major problems confronting public health. Heavy metals make up one of the most important of pollutant in food supply (*PROTASOWICKI, 1992*). From this group, lead, cadmium and mercury have received increasing attention. this attention has been foccused due to adverse toxic effects caused by lead (*SUBRAMANIAN, 1988*), cadmium (*FRIBERG* et al., *1986*) and mercury (*MANAHAN, 1989*).

Animal received heavy metals by means of air, water and feeds (*ANTONIOU, 1989*). Ingested contaminated feeding stuffs has been considered as the main source of metal residues in secreted milk. Moreover, lead contamination from soldered cans is one of post-secretory contamination of milk products (*CARL, 1991*).

Milk samples examined by several workers *BRUHN and FRANK 1976; FAVRETTO and MARLETTA, 1984; UKHUN* et al. *1990 and PROTASOWICKI 1992)* contained heavy metal residues. *LOPEZ* et al. *(1985)* recorded that the lead in pasteurized cow milk was the same in raw cow milk. Moreover, *MURTHY and RHEA (1968)* reported that the cadmium level in raw milk was nearly the same in pasteurized milk. Therefore, heavy metal residues remain with milk during pasteurization. Thus, milk products tend to have the same residue levels as original milk.

This work was conducted to detemine lead, cadmium and mercury in some milk products, randomly collected from different localities in Zagazig City, Sharkia Governorate.

MATERIAL and METHODS

Twenty five random samples of dairy products including pasteurized, sterilized, powdered, fermented and condensed milk (five sample each), were collected from different localities in Zagazig City. The collected samples were transferred to the laboratory for heavy metal analysis.

The extraction of different milk products was conducted according to *HANKINSON (1975).* Condensed and powdered milk were reconstituted with deionized warm distilled water. 50 ml of milk samples (pasteurized, sterilized, fermented, reconstituted condensed and powdered milk) were placed in 250 ml flask. An equal volume of 20% Trichloroacetic acid were added. The sample was Shaken for about 30 minutes with intervals of five minutes and filtered through a 0.45 μ membrane filter. Lead, cadmium and mercury in filtered samples were identified and quantified by using Perkin Elmer 2380 Atomic Absorption Spectrophotometer. The analytical detection limits for lead, cadmium and mercury were 0.05, 0.003 and 0.001 ppb, respectively.

RESULTS

Are Present in Table 1.

DISCUSSION

Concerning lead residues in different milk products, Table (1) revealed that the average of lead in pasteurized, sterilized and fermented milk were 1.501, 1.087 and 4.694 ppm, respectively. Also, the mean concentration of lead in condensed and powdered milk were 11.071 and 8.133 ppm. Similar findings for lead in pasteurized milk were recorded by *LOPEZ* et al.

(1985). Meanwhile, BRUHN and Frank (1976) reported that the value of lead in evaporated milk was 184.3 µg/kg. Moreover, UKHUM et al. (1990) examined powdered milk and found that the average of lead was 0.30 ppm. No data were found in literature for lead in fermented and condensed milk.

Hygienic standards of the contents of foreign substances in food, state that 0.1 ppm is the maximum lead content in milk (BARTIK and PISKAC, 1981). Hence, all examined milk products samples were above this maximum recommended limit. Lead is considered one of the most important pollutant in our environment and distributed widely in classes of natural foods (SHEHATA and NAGAH, 1992) It is accumulating poison, inhibit haemoglobin synthesis (CARL, 1991). and affecting neurological and psychromotor (UKHUN et al., 1990). Moreover, lead reduce function or complete breakdown of kidney, liver and brain (FORSTNER and WITTMAN, 1983).

The mean value of cadmium in examined milk products were 0.038 ppm (pasteurized milk), 0.060 ppm (sterilized milk) and 0.218 ppm (fermented milk), while the average concentration of 0.438 and 0.604 ppm were detected in condensed and powdered milk. The results of cadmium in pasteurized milk are in agreement with those reported by MURTHY and RHEA (1968). In milk powder the results are nearly similar to what found by BRUHN and FRANK (1976) and UKHUN et al. (1990).

The levels of cadmium in examined milk products were above the permissible limit (0.005 ppm) for milk recommended in some countries as Netherland, Hungary and Germany (CARL, 1991). Cadmium is one of the most toxic metals and every day new data on its toxicity are coming in (ANTONIOU et al. 1989). It acts on sulfhydryle groups of essential enzymes and binds to phospholipids and nucleic acid, also it has been shown to interfere with oxidative phosphorylation and replace zinc in metal enzymes which changes its activity (CARL, 1991). Cadmium is a possible cause of hypertension, kidneyailment and testicular atrophy (LOVETT et al., 1972). Moreover, cadmium may induce prostate cancer and functional and morphological changes in many body organs (LAWUERYS, 1978).

The average of mercury in pasteurized, sterilized and powdered milk were 0.086, 0.091 and 0.55 ppm, respectively. The mercury could not be detected in fermented and condensed milk. Similar results were reported by GOMEZ and MARKAKIS (1974), MOTVIJCUK et al. (1987) and RIOLFATTI and VERONESE (1990).

The concentration of mercury in pasteurized, sterilized and powdered milk exceeded the guide line level (0.01 ppm) for milk established by Netherland, Hungary and Germany (CARL,

1991). Mercury is not essential for man. Due to its affinity to sulfhydryle group in protein, mercury compounds are potent enzyme poison *(ROSSI and SANTARONI, 1976)*. It causes neurological effects and embryotoxicity *(CARL, 1991)*. Moreover, it causes sever kidney damage in both man and animal *(MANAHAN, 1989)*.

Based on chronic toxicity studies, the provisional Tolerable Weekly Intake (PTWI) of heavy metals in food for adult (60 kg b.w.) established by the joint FAO/WHO Expert Committee on Food Additives, was 0.05 mg/kg b.w. for lead, 0.007 mg/kg b.w. for cadmium and 0.005 mg/kg b.w. for mercury. Therefore, the level of lead, cadmium and mercury in the examined milk products represents high percent from the acceptable dietary intake of heavy metals.

From the obtained results, it is noticed that the concentration of lead and cadmium are comparatively higher in condensed, fermented and powdered milk than in pasteurized and sterilized milk. Also, the level of mercury is higher in milk powder than in pasteurized and sterilized milk. This may be attributed to the concentration of total solids as a result of water evaporation.

In conclusion, the high lead, cadmium and mercury recorded in examined milk products constitute a possible health hazardous effect for man and animal. A regular and representative monitoring of heavy metals contamination of milk and milk products at an appropriate frequency is recommended. Cans with lead containing solder should not be used for packing of powdered and condensed milk. Moreover, care should be taken to ensure that generally the dairy equipments does not contaminate the milk.

REFERENCES

Antoniou V., Tsoukali-Papadopoulou H.; Epivatiamos P. and Nathanael B. (1989): Cadmium concentrations in beef consumable tissues in relation to age of animal and area of their breeding, Bull. Environ. Contam. Toxicol. 43:915-919.

Bartik M. and Piskac A, (1981): Veterinary toxicology. 1 st ed. Elsevier scientific publishing company. Amsterdam, Oxiford, New York, P. 108-118.

Bruhn J.C. and Frank A.A. (1976): Lead and cadmium in California raw milk. J. Dairy Sci. 59(10): 1711-1717.

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

FAO/WHO, Joint Expert Committee on Food Additives, WHO Technical Report Series No, 505 (1972): No. 555 (1974c); No. 751 (1987) and No. 776 (1989). Evaluation of certain Food additives and contaminants, Geneva.

Favretto L.G. and Marletta G.P. (1984): Heavy metals in milk and milk products. Rivista della Societa Italiana di Scienza dell' Alimentazione, 13 (3): 237-242. Dairy Sci. Abstract, 49 (8), 1987.

Forstner N. and Wittmann G.T.W. (1983): Metal pollution in the aquatic environment. Springer-Verlag, Berlin.

Friberg L., Kjellstrom T. and Nordberg G.F. (1986): Cadmium. In Handbook on the toxicology of metals, Vol. 2 Friberg L., Nordberg G.F. and V.B. (eds.) Elsevier, Amsterdam, pp. 130-184.

Gomez M.I. and Markakis P. (1974): Mercury content of some foods. J. Food Sci. 39: 673-675.

Hankinson D.J. (1975): Potential source of copper contamination of farm milk supplies measured by Atomic Absorption Spectrophotometer. J. Dairy Sci. 58:326.

Lawuerys R.R. (1978): Health effects of cadmium. In: Ferrant E.D. (ed) Trace Metals: Exposure and Health Effects. Pergamon Press, Oxford, P.43.

Lopez A., Collins W.F. and Williams H.L. (1985): Essential elements, cadmium and lead in raw and pasteurized cow and goat milk. J.Dairy Sci. 68 (8): 1878-1886.

Lovett R.J., Gutenmann W.H., Pakkala L.S., Youngs W.O. and Lisk D.J. (1972): A survey of total cadmium content of 406 fish from 49 New York fresh water. J. Fish Res. Bd. Canada, 29: 1283-1290.

Manahan S.E. (1989): Toxicological chemistry. A guide to toxic substances in chemistry. Brooks/cole publishing Co. C.A.

Matvijcuk V.M., Zulenko V.N., Belousov A.L., Cvirko I.P. and Pazout V.(1987): Mercury in milk and milk products. Veterinarstvi, 37 (11): 491-493. Dairy Sci, Abstract, 51 (2), 1989.

Murthy G.K. and Rhea U. (1968): Cadmium and silver content of market milk. J. Dairy Sci. 51 (4): 610-613.

Protasowicki M. (1992): Heavy metals content in the selected food. 3rd World Congress, Food born infection and intoxication, 16-19 June, Berlin.

Riolfatti M. and Veronese M. (1990): Heavy metals in milk formulas. Igiene Moderna, 93 (6): 1090-1100. Food Sci. Techn. Abstract, 23 (4), 1991.

Rossi L.C. and Santaroni M.S. (1976): Mercury and Selenium distribution in a defined area and its population. Archives of Environmental Health, P. 160-165.

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

Subramanian K.S. (1988): Lead. In quantitative trace analysis of biological materials. McKenzie H.A. and Smythe (eds.), Elsevier, Amsterdam, PP. 589-604.

Ukhun M.E., Nwazota J. and Nkwocha F.O. (1990): Level of toxic mineral elements in selected foods marketed in Nigeria. Bull. Environ. Contam. Toxicol. 44: 325-330.

Table (1): The concentration of lead, cadmium and mercury, ppm (mg/kg) in different milk products.

Milk products	No. of examined samples	Lead				Cadmium				Mercury			
		No. of positive samples%	Min.	Max.	Average	No. of positive samples%	Min.	Max.	Average	No. of positive samples%	Min.	Max.	Average
1- Pasteurized milk	5	5	1.312	1.835	1.501	5	0.034	0.046	0.038	5	0.075	0.095	0.086
2- Sterilized milk	5	5	0.983	1.160	1.087	5	0.048	0.068	0.060	4	0.081	0.099	0.091
3- Fermented milk	5	5	3.188	6.761	4.694	5	0.189	0.273	0.218	-	-	-	-
4- Condensed milk	5	5	9.912	13.134	11.071	5	0.372	0.562	0.438	-	-	-	-
5- Powdered milk	5	5	6.364	10.007	8.133	5	0.521	0.760	0.604	5	0.503	0.634	0.556

- : Not detected