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Ecological and Health Risk Assessment of Some Heavy Metals in Natural and Powdered Milk for the Baby and Their Foods Available for Consumption in AL-Amirah City – Iraq

Hayder Dawood Saleem [1] and Anfal Jabbar Taher [2]

[1, 2] Public Health Department, College of Veterinary Medicine, University of Wasit, Wasit, Iraq

Emails: Hydrsalim@gmail.com [1], Ajtbio69@gmail.com [2]

Abstract:

This study focused on estimating lead and cadmium levels in 108 samples dedicated to feeding children, including buffaloes milk, cow's milk, infant dried powder milk, liquid pasteurized milk, condensed milk, and food consisting of rice, wheat, cereal and fruits, from different regions and local markets from Amarah city, which is considered one of the most important components of the basic meals for children was determined using atomic absorption spectrometer. The results showed accumulations of lead and cadmium elements in the studied samples with a concentration rate of 0.95, 0.244 and 0.65, 0.146 and 0.25, 0.073 and 0.387, 0.251 and 0.499, 0.295 mg / kg in buffalos' milk, cows, infant dried powder milk, liquid pasteurized milk and condensed milk respectively. The concentration rate for foods consisting of rice 0.279, 0.0815 mg / kg, wheat 0.227, 0.092 mg / kg, cereal 0.1965, 0.0595 mg / kg and fruits 0.317, 0.091 mg / kg for lead and cadmium, respectively. On the other hand, the results of the chemical analyze of this study showed that there is contamination with lead and cadmium elements in the studied samples and it was more than the permissible limits globally and at an insecure level for human consumption.

Keywords: Baby foods, Heavy metals, Lead, Cadmium, Milk

Introduction

Toxic metals in food have become a major public concern worldwide in recent decades due to their toxicity and bioaccumulation (Qin *et al*. 2009; Saleem *et al*., 2021). Milk products are capable of accumulating heavy metals from diets and the surrounding environment, which may pose a potential health threat to humans, especially children, because the initial development in the digestive system results in high absorption (Al-Khodari *et al*., 2013; Abdelkhalek *et al.,* 2015; Gharban and Yousif, 2020, 2021).

Increased environmental pollution has accelerated the problems of contamination of milk and alternative foods for children. Worldwide, milk is contaminated by environmental pollutants and foreign compounds through livestock feed such as heavy metals, mycotoxins, dioxins and other contaminants to have a greater impact on public health (Yang *et al.,* 2014; Al-gharban and Dhahir, 2015). The absorption of contaminated milk acts as an additional source of exposure to heavy

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metals (Kazi *et al.,* 2009). Industrial or domestic effluents, combustion, forest fires, decomposition of chemical fertilizers, and pesticides are the main sources of mineral pollution for humans (Kacholi and Sahu, 2018).

It is believed that high exposure to metal-contaminated air has proven negative effects on human health. For example, eating food contaminated with cadmium would lead to bone fractures, kidney dysfunction, and even cancer (Al-Jalabi and Al-Attar, 2006; Fu, 2014). Prolonged exposure to lead (Pb) may lead to memory deterioration, and decreased ability to comprehend. In addition, copper (Cu) and zinc (Zn), which are essential micronutrients for living organisms, also have dangerous non-carcinogenic effects on human health when exposure to them exceeds the permissible limits for reference doses (US EPA, 2015). Therefore, in order to ensure the health of the consumer, it is necessary to determine the remaining concentrations of minerals in food (Al-Sarawi, 2008).

Contamination of food by metals and other toxins is one of the most important issues in developing countries (WHO, 2017). There are many studies conducted around the world associated with health risks for example the study of arsenic in rice grown in Sri Lanka (Channa *et al.*, 2015), trace minerals and alpha toxins in cassava flour in West Africa (Hayford *et al*,. 2016), and the metal-contaminated mushrooms in Ethiopia (Medhanye *et al.*, 2016), as well as the health risks of plant and soil contamination in Nigeria (Olayiwola *et al.*, 2017) and Bangladesh (Tasrina *et al.*, 2018). However, it has been observed that the continuous long-term exposure of consumers to heavy metals by consuming raw milk is in lower concentration in developing countries particularly in Iraq.

Due to the lack of research related to the determination of heavy metals in the content of infant formula and food in Iraq, and due to the serious problems associated with the ingestion of these metals in food, this study was planned to shed light on the determination of lead and cadmium and to evaluate their content and compare it with the maximum limits permitted by the World Health Organization.

Materials and working methods

Sample collection

Samples were collected from the most crowded places in the center of Al-Amarah city center (Figure 1), where the number of analyzed samples reached 108 samples designated for feeding children, and included the examination of 24 samples of raw milk from buffaloes and cows collected from the cases received to the veterinary hospital in Al-Amarah city, as well as from the cow breeding field in Some fields and farms in the city also included the examination of 36 samples of milk suitable for consumption from powdered milk for children, pasteurized liquid milk and condensed milk, according to what was available in the markets of the city of Al-Amarah. As

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well as examination of 48 samples of food consisting of rice, wheat, grains and fruits, at an average of 12 samples for each production batch.

Figure (1): Map showing the locations of sampling from the study area

Sample preparation

The method (Saracoglu *et al.*, 2007) was followed by taking 1 gm (solid sample) or 5 ml (liquid sample) in the digestion flask, then dissolved in 5 ml of deionized water, each sample was digested by adding 5 ml of acid. Hydrochloric (5N.HCl) and leave the flask for a quarter of an hour, then placed on a hot plate until the acid evaporates and the solution becomes clear, then add 1 ml of hydrogen peroxide (30% H2O2), then cool to room temperature and repeat this three times, then complete the volume to 25 ml of deionized water in a glass beaker, after which it is ready to be read by the Flame Atomic Absorption spectrophotometer. The following equation was applied: Concentration (mg/L) = reading of the device x volume of the sample after concentration / volume of the sample

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Results and discussion

It was noted in Table (1) that the concentrations of the studied elements (lead and cadmium) exceeded the permissible limits of the international standard (FAO/WHO, 2002), where the concentration of lead in buffalo milk ranged between 0.33-1.57 mg/kg, cows' milk between 0.24-1.06 mg/kg, powdered milk for infants between 0.07-0.43 mg/kg, pasteurized liquid milk between 0.054-0.72 mg/kg, and in condensed milk 0.089-0.91 mg/kg. As for foods consisting of rice, the concentration of lead ranged between 0.027-0.531 mg/kg, foods consisting of wheat between 0.019-0.435 mg/kg, foods consisting of grains 0.116-0.277 mg/kg, and in foods consisting of fruits between 0.153-0.481 mg /kg. As for cadmium, the results showed that its concentrations were less than lead, as it ranged in buffalo milk between 0.039-0.45 mg/kg, cow's milk between 0.032-0.26 mg/kg, powdered milk for children between 0.016-0.13 mg/kg, pasteurized liquid milk between 0.022-0.48 mg/kg, and in condensed milk 0.041-0.55 mg/kg. While its concentrations in foods consisting of rice ranged between 0.011-0.152 mg/kg, foods consisting of wheat between 0.005-0.179 mg/kg, foods consisting of grains 0.006-0.113 mg/kg, and in foods consisting of fruits between 0.017-0.165 mg/kg. kg. The lead element recorded the highest concentration in raw milk of buffalo and cows, at a rate of 0.95 mg/kg and 0.65 mg/kg, respectively, while the lowest concentration was in food consisting of wheat and grains, at a rate of l0.227 mg/kg and 0.1965 mg/kg, respectively. Regarding cadmium, the highest concentration in condensed milk was 0.295 mg/kg, and the pasteurized liquid milk was 0.251 mg/kg, and the lowest concentration in food consisting of rice and grains was 0.0815 mg/kg and 0.0595 mg/kg, respectively.

Table (1) that the concentrations of the studied elements

(Cd) Cadmium		Lead element (Pb)		Type sample
Highest concentration	Lowest concentration	Highest concentration	Lowest concentration	
0.45	0.039	1.57	0.33	Buffalo milk
0.26	0.032	1.06	0.24	Caw milk
0.13	0.016	0.43	0.07	Milk Powder
0.48	0.022	0.72	0.054	pasteurized liquid milk
0.55	0.041	0.91	0.089	Condensed milk
0.152	0.011	0.531	0.027	Food made from rice
0.179	0.005	0.435	0.019	Wheat based foods
0.113	0.006	0.277	0.116	Food made from grains
0.165	0.017	0.481	0.153	Food made from fruits
0.1		0.3		International

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		permissible limits

The large discrepancy in the elements of lead and cadmium within the same type of baby food is due to many sources, including contamination of the food during the manufacturing process, as well as contamination of the raw material of raw milk to which heavy elements are transferred through milking tools and utensils used for drinking water and fodder, as well as the use of chemical pesticides by farmers (Insecticides and fungicides) which are included as part of the feed ingredients for farm animals (Leonidis *et al.*, 2010) and (Mahmoud, 2011). But if the material is rice, wheat or grains, heavy metals (lead, cadmium) are transferred to it through atmospheric deposition on the surface of plants due to the difficulty of absorbing it from the soil and this was confirmed by (kpong *et al.*, 2013) and (Ghazi *et al*., 2009). Research also indicates that harmful environmental factors combined in summer and winter, which differ from one region to another, lead to variation in the rates of pollution with heavy metals and affect animal health and then lead to a difference in the rates of concentrations of these elements (Yildiz *et al.,* 2008; Al-Khudari *et al.,* 2013).

We conclude from this study that there is lead and cadmium contamination in samples of milk and alternative baby food, as all samples exceed the permissible limits internationally, except for foods consisting of cereals for lead, which recorded the highest concentration of 0.277 mg/kg, although the heavy elements released to the atmosphere Or it is spread over the surface of the earth through various industries, as well as car exhaust, which causes an imbalance in the ecosystem, as a result of its marked increase through the increase in population on the one hand and the increase in per capita consumption rates on the other hand. This study recommends the necessity of conducting a comprehensive national survey to follow up on the concentration of other toxic heavy metals, not only for baby food, but also for other foods, especially those foods that are highly consumed by individuals, given the danger of these elements and their effects on human health in the short and long term. As well as activating the supervisory role of the quality control device on imported baby food and ensuring the levels of heavy elements in it.

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