Int. j. adv. multidisc. res. stud. 2022; 2(6):765-767

Received: 18-10-2022
Accepted: 28-11-2022

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

Heavy Lead Metal Determination Concentration in Cheese

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Abstract
The concentration of the heavy element lead in cheese samples was investigated using the atomic absorption spectrophotometer. 72 random samples from six country groups (Iran, Iraq, Egypt, Turkey, Hungary, and Saudi Arabia) available in Iraqi markets were collected. Pb concentration rates in cheese samples were discovered. The non- carcinogenic risk parameters for health from the accumulation of Pb, such as daily Pb metal intake (EDI_{Pb}), the Pb target hazard quotient (THQ_{Pb}), and the Pb carcinogenic risk (CR_{Pb}) were revealed. The highest average Pb metal level in the samples was found in Iranian cheese, while the lowest was in Iraqi ones. The descending Pb order of the countries was Iran > Egypt > Turkey > Saudi Arabia > Hungary > Iraq, according to the T-test confirmation. The EDI_{Pb}, THQ_{Pb}, and CR_{Pb} values were less than the permissible and risk values. Eventually, the health risk parameters revealed that there are no pose risks from those cheeses to Iraqi consumers.

Keywords: Lead Heavy Metal, Flame Atomic Absorption Spectrophotometer, Carcinogenic Risk, Cheese Samples

1. Introduction

Heavy metals are natural elements when compared to the density of water is five times more [1]. When their concentrations increase in the ecosystem, their effect is negative because living organisms need them in limited proportions [2]. Due to the uses of heavy metals such as lead, copper, cadmium, cobalt, silver, etc., especially in recent times in industrial areas, they have contributed to an increase in the exposure of humans and living organisms to them, in addition to their concentrations that are naturally present in the earth's crust and which contribute to the process of transporting them through air, water, and even rock erosion processes. Untreated industrial and domestic wastes of human activities, such as mining, oil derivatives extraction, factory and hospital wastes, are all sources of heavy metal pollution, causing destruction to the environment and the bodies of living organisms when accumulated in it due to the difficulty of their decomposition [2]. Globally, the problem of heavy metal pollution has become the focus of attention for researchers and international health organizations. Because of its danger and toxicity and the inability of living organisms' bodies to analyze it biologically, metals enter the bodies of living organisms through water, air, soil, and foods contaminated with these metals. Cheese is one of the foods we eat on a daily basis because of the numerous nutrients it contains and the benefits it provides [3]. Heavy metals, one of the most significant and complicated pollutants, can contaminate cheese [4]. Pollution may occurs mainly as per pollutants intake by animal's produced milk or throughout dairy production [5]. Pollution of the environment of livestock and their feed with heavy metals such as lead, cadmium, chromium, nickel, and cobalt leaves its effect by being transmitted in the milk of those cattle at different levels, causing very serious problems [6]. Many surveys around the world used various technical methods to investigate heavy metals in cheese specimens [7-10]. The goal of this survey is to analyze lead concentrations as heavy metals in selected specimens of foreign and Iraqi-made canned cheese using the device of atomic absorption spectrometer technique. Another goal is to reveal carcinogenic and non-carcinogenic health risks to adult consumers of these cheeses.

2. Methodology

2.1 Collection of samples

72 random cheese samples from six countries were collected from different markets in Najaf Governorate, Iraq. 15 samples from Iran, Turkey, and Hungary, and 9 samples from Iraq, Egypt, and Saudi Arabia) were collected in September 2022. Without delay, the samples were put in polyethylene containers, having identified labels for each sample, to take them to the laboratory. The identifying label has the name of this sample and all other specific sample information.

2.2 Analyzing prepared samples
According to the [11], there was wet digestion for each prepared cheese sample. First of all, the samples must be dried at 70°C for 24 hr. A solution of HNO_3 and $HClO_4$ (10:1) was added to 1 gram of each cheese sample, then cold digested at room temperature overnight. The mixture was heated after 12 hours and let it evaporate, leaving about 1 ml of residue. Each digested sample, after cooling, was filtered in a volumetric flask covered with Whatmann paper after adding 25 ml of DI water to it to be ready for analysis. All the filtered samples were analyzed using a flame atomic absorption spectrophotometer, Shimadzu model AA7000, USA.

3. Calculations
3.1 Daily Pb Metal Intake (EDI_{Pb}):
Depending on the Pb concentrations C_{Pb} in (ppm) units in the cheese samples, the estimation of daily Pb intake (EDI_{Pb}) from the cheese consumption done by the formula [7, 12]:

$$EDI_{Pb}\ (ppm\ per\ day) = \frac{C_{Pb} \times W_{cheese}}{BW} \qquad (1)$$

For adults, the average body weight (BW) in kg was taken 70, in this study, and the weight of the consumption cheese W_{cheese} daily in kg was 0.022 [7, 13].

3.2 The Pb Target Hazard Quotient (THQ_{Pb}):
By depending on the daily Pb metal intake in equation (1) and the dose of the daily oral reference (RfD_{Pb}) in ppm for Pb which equals to 3×10^{-3} [14, 15], the Pb target hazard quotient can be found from the formula [16, 17]:

$$THQ_{Pb} = \frac{EDI_{Pb}}{RfD_{Pb}} \qquad (2)$$

3.3 The Pb Carcinogenic Risk (CR_{Pb}):
The CR_{Pb} value due to the populations Pb exposure calculated by the formula [18]:

$$CR_{Pb} = \frac{EFr \times ED \times EDI_{pb} \times CSFo_{Pb}}{AT \times 70\ year} \times 10^{-3} \qquad (3)$$

Exposure frequency to the Pb (EFr) in days per year was 350, while 30 years is the duration of exposure to the Pb (ED), and 365 was the average daily time per year (AT) [19]. The daily ppm of the oral carcinogenic slope factor from the Pb ($CSFo_{Pb}$) was 0.0085 [20].

4. Outcomes and discussions
By using the atomic absorption spectrophotometer technique, Pb concentrations and the related health risk parameters were estimated in 72 canned cheese samples which available in Iraqi markets. Table 1 includes the findings of Lead concentrations of cheese samples as averages, as well as, the average health risk parameters. It revealed that the rates of Pb concentrations in ppm units for the selected samples of cheese of this study were higher in Iranian cheese, while lower in Iraqi ones. The maximum value of average Pb concentration in Iranian samples attributable to the variation between Iraqi and foreign samples, as well as sample storage manners in Iraqi markets

The average Pb concentration levels in cheese samples, were above the maximum rate of the EC Commission, Codex standards, and EU Regulations 0.02 ppm [20, 21], as shown in Table 1. But the accumulation results because of the long-time consumption revealed that all risk parameters of health as the Pb heavy metal in the investigated cheese samples of this study below the recommended level. The EDI_{Pb} and THQ_{Pb} of all of the tested cheeses used in this survey found to be below the global limits 3.57 $ppm\ per\ day$ and 1, respectively [22, 23]. The carcinogenic risk outcomes $CR_{Pb} \times 10^{-6}$ as per Lead concentrations is depicts in Table 1. CR_{Pb} values for tested cheeses diverse from one country sample to another. Referring to the recommended ranges of the Environmental Protection Agency $10^{-4} - 10^{-6}$ [19], the CR_{Pb} average results for tested cheeses have limits under the recommended. Fig 1 shows a comparison between the rates Pb concentrations in the current study in selected canned cheese samples and other country studies (Mexico [24], India [9], Georgia [10], Bulgaria [25], and Bangladeshi [22]) which referred that the current study times higher. The descending order of the countries of the average results of cheese was Iran> Egypt> Turkey> Saudi Arabia> Hungary> Iraq, as per to the T-test confirmation. The variations in the Pb concentration ranges of all specimens are significant ($p < 0.05$) for a range of factors, which would include pollution by lead in plants consumed by milk-producing animals, pollution during the cheese manufacturing operation, and pollution by the different types of cheese packaging canned, among others.

Table 1: Averages and Standard Errors of Pb calculations

Country	C_{Pb}	EDI_{Pb}	THQ_{Pb}	$CR_{Pb} \times 10^{-6}$
Iran	4.333 ± 0.571	1.588 ± 0.209	0.454± 0.059	0.006± 0.0007
Iraq	2.888 ± 0.436	1.059 ± 0.159	0.302 ± 0.045	0.003 ± 0.0006
Egypt	4.281 ± 0.573	1.570 ± 0.210	0.448 ± 0.060	0.005 ± 0.0007
Turkey	3.899 ± 0.634	1.430 ± 0.232	0.408 ± 0.066	0.005 ± 0.0008
Hungary	3.652 ± 0.614	1.339 ± 0.225	0.382 ± 0.064	0.004 ± 0.0007
Saudi Arabia	3.662 ± 0.670	1.343 ± 0.245	0.383 ± 0.070	0.004 ± 0.0008
Allowed Values	0.02 [20, 21]	3.57 [22]	1 [23]	10^{-4}-10^{-6} [19]

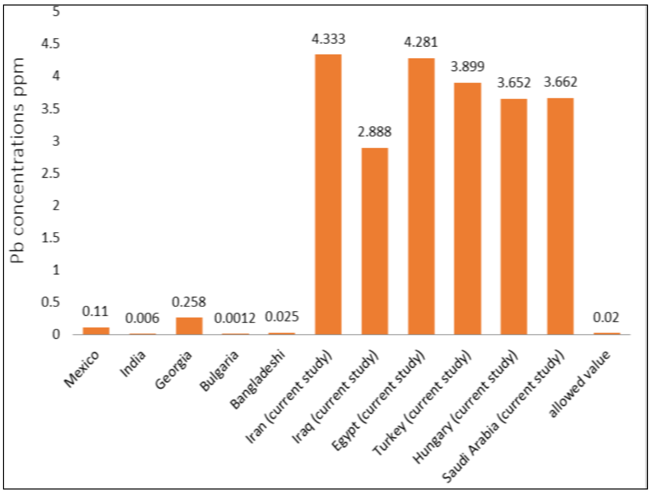

Fig 1: Comparison between current and other country studies

5. Conclusions
The results of the present study, related to the Pb concentrations, indicated that the analyzing results of the samples, according to the EC Commission, Codex General Standard, and European Regulations, compared with the world averages were found to be the highest. However, the findings of the non-carcinogenic (EDI_{Pb} and THQ_{Pb}) and carcinogenic health risk parameter CR_{Pb} based on the Pb concentrations were permissible within the global limits. Eventually, the risk parameters of health revealed that there are no pose risks from those cheeses to Iraqi consumers.

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