Full Length Research Article
Advancements in Life Sciences – International Quarterly Journal of Biological Sciences

ARTICLE INFO

Date Received: 01/07/2023;
Date Revised: 12/09/2023;
Date Published Online: 20/10/2023;

Authors' Affiliation:
Department of Biology, College of Science, University of Wasit , Kut - Iraq

***Corresponding Author:**
Ahmed Mahdi Al-Badri
Email:
ahmedalmyahi@yahoo.com

How to Cite:
Al-Salman AAJ, Al-Badri AM (2023). Bioaccumulation of Lead and Cadmium in Fresh Local and Imported Frozen Beef Livers. Adv. Life Sci. 10S(1): 101-105.

Keywords:
Livers; Cadmium; Lead; Frozen; Beef

Open Access

Bioaccumulation of Lead and Cadmium in Fresh Local and Imported Frozen Beef Livers

Asawer Abdul Jabbar Al-Salman, Ahmed Mahdi Al-Badri*

Abstract

Background: There are insufficient biochemical studies on the contamination of livers with heavy metals by means of the food source for these cattle or poor packaging and storage.

Methods: This study used an atomic absorption spectrophotometer (ASS) device to measure the concentrations of lead and cadmium, in which 18 samples of livers by three products were collected from butchers and markets in Wasit Governorate (Fresh local livers, Iranian and Indian frozen livers) with 6 samples for each product.

Results: According to the findings of the biochemical tests for heavy metals, the frozen Indian and Iranian liver had the highest mean of Pb levels (0.2958 and 0.3810) while, the fresh local livers had the lowest mean (0.2532). On the other hand, the data showed that the highest mean of Cd accumulation were identified in frozen livers from India and Iran, whereas the lowest mean was in local livers as (0.3688, 0.2098 and 0.0697) respectively. Statistical analysis found that there was highly significant difference in livers ($P \leqslant 0.05$) in the mean content of Pb and Cd.

Conclusion: This study provided us with a good concept that consuming fresh livers is better than frozen because frozen products are exposed to many factors of contamination with unhealthy pollutants, in addition to poor storage and the different degrees of freezing to which these products were exposed, which negatively affects people's health.

Introduction

Lead is a non-essential hazardous element that may mostly be absorbed by the lungs or intestine and its detrimental effects on health have long been known [1]. There are many ways that lead can enter the food chain, including direct airborne deposition on edible plants, meat from animals that has been exposed to polluted plants, water and air [2]. Lead has been designated as a carcinogen by the International Agency for Research on Cancer (IARC). Pb linked to brain damage in adults, as well as mental problems and reduced manual dexterity. In addition to neurological toxicity, Pb can result in other health issues like delayed sexual maturation decreased sperm quality and quantity, increased abortion rates, developmental delays, hypertension brought on by a drop in blood nitric oxide (NO) levels, impaired hemoglobin synthesis, fatigue, insomnia, anemia, irritability, osteoarthritis, headaches, constipation, weight loss, joint pain and muscle pain [3].

Cadmium is a persistent, non-biodegradable and physiologically unnecessary heavy metal that poses a considerable risk to both human and animal health. It affects all animals, including dogs, horses, birds and other livestock [4]. The WHO has established an acceptable limit for Cd of 0.49 ppm/body weight/week [5]. Humans are exposed to cadmium through food more so than through cutaneous contact or inhalation. Cd can easily be conveyed to animals grazing on such contaminated plants due to the quick uptake of the metal by leafy vegetables and crops from contaminated soil; thus, it accumulates mostly in their tissues [6]. It can replace zinc and other metals in some of the organism's enzymatic reactions, interfering with various pathological processes like renal dysfunction, hypertension, arteriosclerosis, growth inhibition, nervous system damage, bone demineralization and endocrine disruption [7]. The aim of this study is to determine the amount of (lead and cadmium) required to identify potential risks to consumers.

Methods

Samples Collection

18 samples of fresh local besides imported frozen Iranian and Indian beef livers collected from slaughter places and different markets of Wasit Governorate were analyzed by 6 samples for each product using the graphite furnace technique. This is one of the atomic absorption spectrometric methods with high sensitivity, as it reaches the lowest limit of detection minerals.

Biochemical Preparation

1gram of samples were taken and placed in clean plastic bottles of 50 ml and kept in a freezer until taken to the examination laboratory. Then the samples were subjected to the following procedure:

Digestion of Tissue

Place 1 gram of tissue in a conical flask with 100 ml of water and then place sample at room temperature for an hour before adding 5 ml of concentrated nitric acid ($HNO3$ 70%) and 1 ml of per chloric acid ($HClO4$). Samples were heated to 100 °C on a hot plate until violet vapors appeared. Heat the area (between 150-200 °C) until white vapors start to form. The pale-yellow color of the solution shows that the digestive process is finished. Sample filtering using filter paper. Then fill the remaining space with 25 ml of distilled water that has been slightly acidified (1% $HNO3$). Using an atomic absorption spectrometer's graphite furnace approach read samples [8].

Determination of Pb and Cd

Four standard lead solutions (5, 10, 15 and 20 ng/ml) were made. In the meantime, five standard cadmium solutions were made (2.5, 5, 10, 15 and 20 ng/ml). The concentrations of Pb and Cd in samples were measured directly and continuously in addition to standard solution measurements.

Statistical Analysis

Microsoft Excel and IBM SPSS version 26 software were used to statistically evaluate the findings of the biochemical heavy metals test. The findings of this investigation were presented as mean ± SD. To evaluate for differences between the countries, one sample independent T-test and one-way ANOVA were utilized. 0.05 was used to determine whether the probability values were significantly different.

Results

Lead in Liver

Local and frozen imported bovine liver samples were collected and the accumulation of heavy metals (lead, cadmium) inside these tissues was examined, as revealed in (Table 1). After investigative these results, it was found that the highest percentage of Pb accumulation was (0.447 ppm). This value is higher than the permissible limit according to the organizations FAO/WHO which determined the permissible concentration in liver (0.1 ppm or mg\kg) [9,5]. Whereas the lowest percentage was (0.086 ppm) is lower than the permissible limit This result is similar to what was reached by [10]. when they found the concentration of lead in beef livers was (0.004-0.005) less than the permissible limits.

The results of the biochemical test for the livers of fresh Iraqi showed that the percentage of lead accumulation in those livers ranged between ratios (0.206-0.298 ppm). Consistent with the organizations

FAO/WHO, these values are higher above the acceptable limit. The local livers showed the lowest percentage of lead contamination compared to the imported frozen samples. It is possible that the high percentage of Pb in local livers is due to the fact that Iraq is an oil country and that the spread of pollutants from oil products and others near places of grazing and breeding animals commanded to a high percentage of heavy metals accumulation in the livers of those animals.

Sample	Pb (ppm)	Cd (ppm)
FL1	0.226	0.078
FL2	0.283	0.059
FL3	0.206	0.093
FL4	0.237	0.082
FL5	0.269	0.065
FL6	0.298	0.041
RL1	0.086	0.265
RL2	0.447	0.131
RL3	0.295	0.197
RL4	0.347	0.243
RL5	0.419	0.185
RL6	0.397	0.238
IL1	0.289	0.301
IL2	0.275	0.376
IL3	0.310	0.341
IL4	0.284	0.392
IL5	0.321	0.417
IL6	0.296	0.386

FL: Fresh liver.
RL: Iranian liver.
IL: Indian liver.
Table 1: Bioaccumulation of lead and cadmium in fresh and frozen livers.

On the other hand, Iranian frozen livers showed an accumulation of Pb within range (0.086-0.447 ppm) also higher than the permissible limit. However, results of frozen Indian livers showed the presence of lead deposition in proportions ranging from (0.275-0.321 ppm).

Related to other products from various nations, frozen livers are readily available in markets at low prices. Livers are a food source and the metals discovered in them come mostly from pollution, such as industrial and chemical industries maybe near the feeding area, contaminating the animals' feed besides water and air that they breathe. The other brands that had high Pb levels could have been tainted during manufacturing in the nations they imported from as well as through feed, water and air pollution. On the other hand, most manufacturing factories in poor countries or third world countries choose suitable places to establish factories for export, due to the lack of material costs and manpower.

These places that do not conform to the required specifications are the reason for the poor quality of the product. Likewise, fodder with non-conforming qualities, living place and grazing, etc. All of these reasons lead to the accumulation of pollutants, which are almost available in large proportions in the place of living compared to the other farms. According to the aforementioned conclusions, local fresh liver had the lowest mean of lead deposition (0.2532), whereas Indian and Iranian frozen liver had the highest mean (0.2958), (0.3810). A statistical analysis' results descriptive that there was highly significant difference ($P \leqslant 0.05$) in the three species of liver, as summarized in (Table 2), (Figure 1).

Country	Mean	±	Std. deviation	Std. Error	Range (Min –Max)
Iraq	0.2532	±	0.0357	0.0539	0.0920 (0.2060 - 0.2980)
Iran	0.3810	±	0.0540	0.0539	0.152 (0.2950 – 0.4470)
India	0.2958	±	0.0171	0.0070	0.0460 (0.2750 – 0.3210)

Table 2: Mean and standard deviation of replicate measurement was determined for lead between three types of frozen and fresh livers.

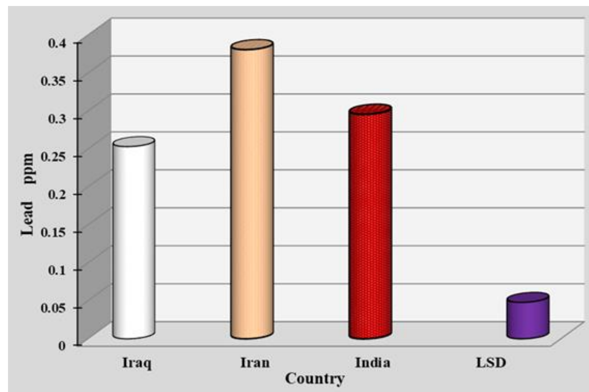

Figure 1: Average concentrations of lead in liver of three countries.

Cadmium in Liver

The results of the bioaccumulation of cadmium in the fresh Iraqi and imported frozen livers shown in (Table1) above. The highest percentage of Cd accumulation was (0.417ppm). According to the organizations FAO and WHO, who established the acceptable quantity of Cd in liver (0.5 ppm or mg/kg) [9,5,15]. While, the lower percentage was (0.041ppm). Samples of the local Iraqi beef livers showed the lowest percentage of cadmium accumulation compared to the imported frozen livers where the concentrations ranged between (0.041-0.093 ppm).

On the other hand, the results of the examination showed that the percentage of Cd accumulation in the frozen liver of Iran within range (0.131-0.265 ppm). In contrast, Indian livers showed levels of cadmium ranging from (0.301-0.417ppm) these values are lower than the allowed level. According to the study's findings, none of the samples examined in this parameter had Cd concentrations over the FAO/WHO-recommended tolerable limit of (0.5 ppm) therefore; all products are safe to human health.

The results above showed that frozen livers from India and Iran had the highest mean of liver contaminated with Cd (0.3688), (0.2098), whereas the lowest mean was found in Iraqi livers (0.0697). The study's results presented that there was highly significant difference ($P \leqslant 0.05$) of cadmium content, as brief in (Table 3), (Figure 2).

Country	Mean	±	Std. deviation	Std. Error Mean	Range (Min –Max)
Iraq	0.0697	±	0.0186	0.0076	0.052 (0.041 – 0.093)
Iran	0.2098	±	0.0489	0.0199	0.134 (0.131-0.265)
India	0.3688	±	0.0414	0.0169	0.116 (0.301- 0.417)

Table 3: Mean and standard deviation of replicate measurement was determined for cadmium between three types of imported and fresh livers.

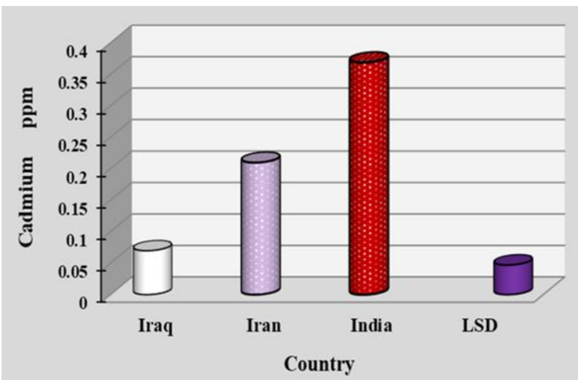

Figure 2: Average concentrations of cadmium in liver of three countries.

Discussion

The results of lead above did not agree with what was reached by [11], who discovered that the fresh chicken livers had the highest lead levels among the frozen livers, but matched what was reported by [12] who measured the concentration of Pb as (0.8936 ppm) in the fresh meat of Najaf cows and by [13] who discovered the lead attribution in Ghanaian goat fresh meat to be (0.001-0).

On the other hand, the tests of Pb in frozen livers were consistent with findings [14] on frozen chicken livers, when he saw the accumulation of Pb between (0.062-0.41ppm). The findings of a study conducted in the north of Iraq to measure the accumulation of lead in locally produced and imported beef meat complement the findings of the present study. This investigation revealed that the highest value of lead was found in frozen beef, while the lowest concentration was found in locally produced fresh meat [16].

The readings reached the same conclusions of [17] findings after observing the livers of slaughtered cattle had a cadmium deposition of (0.008 ppm) and were consistent with what [18], who found that beef contains cadmium at level ranging from (0.001-0.002 ppm). The level of bioaccumulation of Cd in frozen livers were near to what was found by [19] of cadmium accumulation in livers of frozen Iranian chickens, which is (0.37 mg/kg).

However, These findings were in line with the conclusions reached by the researchers [20] in their study carried out in Egypt, which found that different frozen meat from many countries were less contaminated with cadmium than Indian frozen meat.

From this study we conclude, that Iranian and Indian imported livers were found to have the highest significant levels of lead and fresh had the lowest levels. The above products exceeded the internationally permitted limits, so they are unhealthy and safe. On the other hand, the accumulation of cadmium in Indian frozen livers showed a higher rate than Iranian and local fresh livers, but the three products remain within the limits permitted of Cd concentration by the World Health Organization and the Food Agriculture Organization, so they are considered safe and healthy products for the consumers.

Author Contributions

Asawer Abdul Jabbar: she collected the samples, worked on them, obtained the results, analyzed them statistically, and wrote the manuscript.
Ahmed Mahdi: he was the direct supervisor of this work.

Competing Interests

The authors declared that there were no conflictsof interest.

References

1. Hernberg S. Lead poisoning in a historical perspective. American Journal of Industrial Medicine, (2000);38: 244-254.
2. Amchova P, Kotolova H, Ruda-Kucerova J. Health safety issues of synthetic food colorants. Regulatory Toxicology and Pharmacology, (2015);73(3): 914-22.
3. European Food Safety Authority EFSA. Cadmium in food scientific opinion of the panel on contaminants in the food chain. European Food Safety Authority Journal, (2009); 980: 1-139.
4. Abeer GA, Yunjun Y. Alteration of acetyl cholinesterase activity and antioxidant capacity of zebra fish brain and muscle exposed to sub lethal level of cadmium. International Journal of Environmental Science and Development, (2013); 4(3): 327-330.
5. FAO/WHO. Working document for information use in discussion related to contaminants toxins in the GSCTFF. International Joint FAO/WHO Food Standards Programme Codex Committee on Contaminants in Foods, (2017): 1-162.
6. Darwish M, Jomaa I, Awad M, Boumetri R. Preliminary contamination hazard assessment of lead resources in central Bekaa plain of Lebanon. Lebanese Science Journal, (2008); 9(2): 3-15.

7. Lafuente A, González-Carracedol A, Esquifino AI. Differential effects of cadmium on blood lymphocyte subsets. Biometals, (2004);17(4): 6-451.
8. Selvaraju R, Ganapathi Raman R, Narayanaswamy R, Valliappan R, Baskaran R. Trace element analysis in hepatitis b affected human blood serum by inductively coupled plasmaatomic emission spectroscopy (ICP-AES). Romanian Journal Biophysics, (2009); 19(1): 35-42.
9. FAO\WHO. Codex committee on food additives and contaminants. International Joint FAO/WHO Food Standards Programme, (2002); 11-15.
10. Musa Y, Nita D, Emmanuel A, Galo YS, Louis H, Innocent J. Determination of the level of heavy metals in liver and kidney of cow and goat used as meat source in Mubi Adamawa State. International Journal of Research in Environmental Science, (2017);3(3): 1-8.
11. Akan JC, Abdulrahman FI, Sodipo OA, Chiroma YA. Distribution of heavy metals in the liver, kidney and meat of beef, mutton, caprine and chicken from Kasuwan Shanu market in Maiduguri Metropolis, Borno State, Nigeria. Research Journal of Applied Science Engineering and Technology, (2010); 2(8): 743-748.
12. Basim AA, Laith S, Asmaa HA. Determination of alpha particles and heavy metal contamination in meat samples in Najaf, Iraq. Iranian Journal of Medical Physics, (2019);16: 133-138.
13. Richard AJ. Agyenim, Samuel Adzrak. Meat contamination through singeing with scrap tyres in Akropong Akuapem Abattoir Ghana. Applied Research Journal, (2014); 1: 12-19.
14. Elsharawy NTM. Some heavy metals residues in chicken meat and their edible offal in new valley. In Proceedings of the 2nd Conference of Food Safety, Ismailia, Egypt, (2015); I: 53-60.
15. European Commission. Regulation of the European parliament and of the council of 12 May 2014 amending regulation (EC) as regards maximum levels of cadmium in foodstuffs. International Official Journal, (2014); L: 138/75, 13/5/.
16. Azad BS, Nithal YY, Shawnm JS. Essential and toxic metals determination in imported and fresh beef cattle meat sold in Erbil markets. Animal Review, (2020);7(1): 14-18.
17. Hiba S. Al-naemi. Estimation of lead and cadmium levels in muscles, livers and kidneys of slaughtered cattle in Mosul city. Mesopotamia Journal of Agriculture, (2011);39(3): 8-15.
18. Hu Y, Zhang W, Chen G, Cheng H, Tao S. Public health risk of trace metals in fresh chicken meat products on the food markets of a major production region in southern China. Environmental Pollution
19. , (2018); 234: 667-676.
20. Sadeghi A, Hashemi M, Jamali-Behnam F, Zohani A, Esmaily H, Dehghan AA. Determination of chromium, lead and cadmium levels in edible organs of marketed chickens in Mashhad-Iran. Journal of Food Quality Hazards Control, (2015);2: 134-8.
21. Yasser M. Al-Ashmawy, Nader Y. Moustafa, Ibrahim I. Al-Hawary. Heavy metals determination in imported frozen meat. Kafrelsheikh Veterinary Medical Journal, (2012);10(2): 79-89.