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Health risk assessment of lead, cadmium, and copper in meat and liver from local and imported sheep in Basra, southern Iraq

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ABSTRACT

Three hundred samples of thigh meat and livers from local sheep (from both official and random slaughter) and imported Australian thighs were gathered in Basra city throughout the summer and winter seasons. The findings indicated an elevation in the mean concentrations of all examined components in the random slaughter source. The highest average concentration of lead was in the random slaughter source of thigh and liver in summer (1.38±0.404 and 2.2±0.71) mg/kg respectively. While in winter (1.55±0.43 and 2.06±0.6) mg/kg respectively.and, the highest average concentration of cadmium was for the randomly selected thigh and liver sources were 0.144 ± 0.06 and 0.19 ± 0.08 mg/kg, respectively. In the winter, it was 0.101 ± 0.06 mg/kg while in the summer, it was 0.16 ± 0.062 mg/kg. The copper concentration in the official slaughter source of thigh and liver during summer was (3.65 ± 10.92 and 27.883 ± 109.59) mg/kg, respectively. As for winter, it was (14.02 ± 16.57 and 32.003 ± 96.71) mg/kg, respectively. In contrast, The highest average concentration of copper was recorded for the random slaughter source during the summer (17.008± 31.13 and 51.963± 118.17) mg/kg, respectively. While during the winter, it reached (10.262± 16.494 and 42.101± 122.28) mg/kg, respectively. We computed the EDI of nutrients and compared it to the TDI, the THQ, and the HI for thigh lamb, as well as the risk quotient and risk index, respectively. Both adults and children had EDI values that were more than TDI, and THQ values that were lower than 1.0 (<1). That is, there are slight health risks that are not significant for adults, but they are almost significant for children. The HI values were less than 1.0 (<1) for adults. That is, the non-carcinogenic health risks are very small. However, the HI for children was greater than 1.0 (≥1), so there is a possibility of non-carcinogenic adverse health effects after consuming lamb meat.

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1. Introduction

The bioaccumulation, toxicity, and environmental persistence of heavy metals make them a kind of environmental contaminant. One environmental issue that affects human health is the pollution of both terrestrial and aquatic ecosystems with harmful heavy metals. They contaminate food chains because they are persistent contaminants that build up in the environment. People, in particular, are at risk when heavy toxic components build up in living things and end up in the food chain[1, 2]. Heavy elements are formed in the environment by natural processes and human actions. Ecosystems and human health are so greatly endangered by them. Because of this, they can accumulate in a wide variety of species. As a result, worries regarding their possible toxicity, particularly in relation to human exposure, arise[3].

Because it has every one of the amino acids the body needs to carry out its many important tasks, meat is considered a full protein source. In addition, it contains vitamins and important elements such as iron, selenium and zinc[4]. The livestock sector is considered one of the most important sectors with distinction and great development potential. Countries are interested in this sector to achieve national production of meat and dairy products that meet the needs of the local market[5]. There is also a rapid demand for meat consumption recently. This has raised concerns about the various toxic elements that may be present in meat and meat products due to environmental pollution with heavy elements[6].

Lead causes global soil, water and air pollution, and recently, global lead production is expected to increase due to the high manufacturing of cars and mobile phone batteries [7]. Wastewater discharged by a variety of businesses is another known pathway for cadmium to reach our water and environmental systems. It has harmful effects [8], [9]. Both lead and cadmium are potential carcinogens. Lead can cause neurological, renal and gastrointestinal diseases. Cadmium entering the human body can also lead to lung cancer, high blood pressure and kidney dysfunction [10]. Copper is an essential nutrient in the human and animal body [11]. Ruminants, particularly sheep, are particularly vulnerable to chronic copper poisoning and can be poisonous if given too much of it. Studies have shown that spontaneous copper poisoning in sheep has occurred in many parts of the world. This negatively affects human health when consuming such sheep exposed to copper [12].

Human exposure to heavy metals causes multiple harms. Some are temporary, such as poisoning, and others are permanent. They appear in the long term, such as cancer, kidney failure, and mental retardation. For example, when human fetuses are exposed to these elements through mothers and their high sensitivity during growth, this causes premature birth of incompletely developed fetuses. Alternatively, it may cause a decrease in the size of newborns or reduce mental abilities. There is a decrease in the rate of intelligence and growth in children. As for adults, exposure to heavy metals has negative effects on memory and response speed. It also causes general weakness and high blood pressure in men. It causes serious damage to the brain and kidneys in pregnant women [13]. Therefore, it is now required to compare the EDI to the TDI, the THQ, and the intake of elements like the HI that are suggested by worldwide authorities and international food regulations. Which can help determine whether heavy metals in food pose any danger to human health.

2. Materials and methods

2.1. Collection of samples

300 samples were collected during the summer and winter seasons from local and imported sheep meat. Three replicates were taken for each animal. Local sheep samples were selected from official and random slaughter sources. The imported (Australian) slaughter source was from marketing centres. (Thigh and liver) were selected for local sheep aged 1-2 years. Only the thigh was in imported meat. 30-50 grams were taken from the studied samples for digestion. Then, they were stored in clean plastic bags and placed in refrigerated boxes until they reached the laboratory for storage at -20 ◦ C.

2.2. preparation, digestion, and measurement of the sample

To ensure that the study's thigh and liver samples were free of contaminants, they were thoroughly rinsed with distilled water. Afterwards, a ceramic knife was used to chop them into little pieces. Afterwards, the samples were subjected to an electric oven set at 105°C for three hours to dry them. Then, the dried samples were crushed using a ceramic mortar. For elemental analysis, roughly 2 grammes of fine powder were utilized [14]. The heavy element samples were digested according to what was described by the Regional Organization for the Protection of the Marine Environment [15] in 1983 by dry digestion to determine the studied elements. The samples were digested to extract three selected heavy elements, namely lead (Pb), cadmium (Cd), and copper (Cu), from the studied tissues. Nitric acid (H_2NO_2) at a concentration of (65%), concentrated sulfuric acid (H_2SO_4) and hydrogen peroxide at a concentration of (30%) were used for digestion. After digestion, the samples were ready for laboratory analysis. Then, the digested samples were stored in tightly sealed plastic bottles until the required heavy elements were measured using an inductively coupled plasma optical emission spectrometer to determine the heavy elements in the laboratory of the Marine Science Center - University of Basrah.

2.3. Calculation of heavy metal concentrations

The results of the concentrations of heavy metals in tissues were calculated using the following formula as described in[15]. The following calculation was used to compute the residual element concentrations (micrograms per gram):

$$Element = R \times D/W \quad \text{….(Equ 1)}$$

R: is the element concentration readout in parts per million from the gadget. In milliliters, D represents the finished volume of the sample. W: is the sample's weight in grams.
Calculating the values of pollution indicators (health risk assessment):

Estimated Daily Intake (EDI):

The estimated daily intake (EDI) for the studied elements was calculated according to the equation below, which is approved by the Human Health Assessment Guide of the US Environmental Protection Agency[16]:

$$EDI = C \times FIR/BW \quad \text{…..(Equ 2)}$$

C: Concentration of the element in the sample under study (mg/kg), and EDI: Estimated daily intake (in µg/kg/day). On a daily basis, an individual weighing 70 kg in Iraq consumes an average of 32.8 g of muscle tissue [17]. The body weight of both children and adults in Iraq is estimated to be 30 kg for children and 70 kg for adults.

Target Hazard Quotient (THQ)

The following equation, following the recommendation of the US Environmental Protection Agency, was used to compute the non-cancer target hazard quotient (THQ) (for adults and children) linked to the ingestion of examined sheep tissues[18] :

$$THQ = \frac{C \times IR \times EF \times ED}{RFD \times BW \times AT} \dots (Equ\ 3)$$

Where: C: Concentration of heavy metal in food (mg/kg), IR: Daily food consumption rate (kg/day) = in Iraq 32.8 g/day (0.0328 kg/day)[17], EF: Number of days in which food is consumed per year (days/year) = 365 days per year, ED: Duration of exposure (in years) = 70 years, RfD: Reference daily dose (mg/kg/day). Source of the oral dose of elements according to[19], BW: Body weight of the person (kg) = 70 kg, AT: Life expectancy = 365 days × 70 years.

Heavy metals Intake HI

The intake of elements represents the total target hazard quotient Σ (THQ), and its value ranges between (1–10), according to[20], the effects of HI intake depend on the total target hazard quotient.

2.4. Statistical analysis

Analysis of variance (ANOVA) and the Least Significant Difference (LSD) test (0.05) were used for statistical analysis in accordance with the SPSS Ve. 26 statistical system to observe the differences between sources and seasons and below the probability level ($P \leq 0.05$).

3. Results and Discussion

Table (1) shows the concentrations of heavy elements (mg/kg) for sheep thighs and livers in the official and random slaughter source and imported slaughter thighs. The concentrations of heavy elements such as lead in sheep thighs and livers in the official slaughter source for the summer were (1.16 ± 0.4 and 1.96 ± 0.55) mg/kg, respectively. In contrast, they reached (0.55 ± 0.23 and 1.09 ± 0.47) mg/kg in the winter. As for the random slaughter source during the summer, they were (1.38 ± 0.404 and 2.2 ± 0.71) mg/kg, respectively. In the winter, they reached (1.55 ± 0.43 and 2.06 ± 0.6) mg/kg, respectively. In the imported slaughter source in the thigh during the summer (0.972± 1.693) mg/kg, while in the winter, it reached (0.39± 0.738) mg/kg.

Our results showed that the lead concentrations in the sheep's livers were much higher than the allowable limits of 0.5 mg/kg, as stated in [21], when compared to the sheep's thighs. There was a greater concentration of lead in the liver compared to the thigh. These results were similar to the results of many researchers, including the study [22] in Libya. The concentration of lead was measured in the livers and muscles of sheep and camels. The average concentration in the liver was (1.17 ± 93.66) mg/kg. In the muscles (0.15 ± 53.16) mg/kg We notice that The concentration of lead in the liver was higher than its concentration in the thigh. The study [23] in Australia. Results showed an average value of 0.040 mg/kg for the kidneys and 0.007 mg/kg for the muscles in Australian sheep. The Saudi Arabian research [24] found that the highest average level in the sheep's livers was 10.81 micrograms/kg. The liver is the primary site of lead accumulation. On the other hand, lead bioaccumulation during an animal's lifetime is indicated by a high lead concentration in its muscles[25]. The results of statistical analysis indicate that there is a significant difference in lead at $P \leq 0.05$ between the thigh and liver of official slaughter and random slaughter in summer and winter. Its value was $P= 0.000$, as well as a significant effect of lead $P \leq 0.05$ for seasonal changes in the thigh in the imported slaughter source, and its value was $P= 0.000$.

Cadmium concentrations in the thigh and liver of the official slaughter source during the summer were (0.081 ± 0.07 and 0.171 ± 0.105) mg/kg, respectively. During the winter (0.027 ± 0.02 and 0.132 ± 0.152) mg/kg, respectively. Cadmium was recorded for the random slaughter source and during the summer (0.144 ± 0.06 and 0.19 ± 0.08) mg/kg, respectively. During the winter (0.101 ± 0.06 and 0.16 ± 0.062) mg/kg, respectively. In the imported slaughter source in the thigh during the summer and winter (0.064 ± 0.05, 0.017 ± 0.032) mg/kg, respectively. When comparing the average concentrations of cadmium with the permissible limits set by the US Department of Agriculture [20], which are 0.1 mg/kg in meat and 0.5 mg/kg in liver, we find that they are within the permissible limits. It has come to our attention that the elevated summertime cadmium concentrations may be a result of dust storms in the Middle East, which have been an issue in recent years, particularly in southern and southwestern Iran, as well as the surrounding region. From Iran to Iraq, you may experience the dust phenomenon, which is most common in the warmer months. Air pollution may be worsened when dust particles absorb heavy metals released into the air by automobiles and industries. This makes them easier for animals to ingest and increases their [26]. There is a significant effect of cadmium at $P \leq 0.05$ between the thigh and liver for the official slaughter source in the summer and winter. Its value reached $P=0.000$ and for the random slaughter source during the summer, 0.036P= and winter, 0.004P=. There was no significant effect ($P \leq$

0.05) of cadmium on seasonal changes in the thigh in the imported slaughter source, which amounted to 0.372.

The concentrations of copper in the thigh and liver of the official slaughter source during the summer were (3.65± 10.92 and 27.883± 109.59) mg/kg, respectively. During the winter (14.02± 16.57 and 32.003± 96.71) mg/kg, respectively. Copper was recorded for the random slaughter source and during the summer (17.008± 31.13 and 51.963± 118.17) mg/kg, respectively. While during the winter, it reached (10.262± 16.494 and 42.101± 122.28) mg/kg, respectively. In the thigh of the imported slaughter source, it was recorded during the summer and winter seasons (12.49± 17.14, 10.1± 12.33) mg/kg, respectively. Copper is considered a toxic element in the liver of sheep when its concentration reaches 250-1000 mg/kg [27]. There was no evidence that the average copper content in this study was higher than the 200 mg/kg limit set by the Australian New Zealand Food Authority [28]. Copper levels in the liver seemed to be greater than those in the thighs in this investigation. This is because sheep have a small storage capacity for copper in the liver [29]. The total copper in the body of Liver accounts for 72–79 percent of sheep, whereas muscles make up 8–12% [30]. In [31], we found comparable outcomes as well. At 0.018± 538.425 mg/g, the sheep liver contained the greatest quantity of copper. It was also noted that copper concentrations increased in summer more than in winter. This can be attributed to the high temperature in summer and increased evaporation. Consequently, the concentrations of these elements salts in water increased in addition to the increase in human activities and their intensity in summer and decrease in winter [32]. There is a significant effect of copper at P≤0.05 between the thigh and liver for official slaughter and random slaughter in summer and winter, as the value was P=0.000. There is no significant difference P≤0.05 for cadmium for seasonal changes in the thigh in the imported slaughter source, as it reached P=0.486.

Table (1): Concentrations of heavy elements (Means±SD) (mg/kg) for sheep thighs and livers in the official, random and imported slaughter sources

Source	**Heavy Metals** / **Body Part**		**Pb**	**Cd**	**Cu**
Official	Thigh	summer	1.16 ± 0.4	0.081 ±0.07	١٠,٩٢ ±٣,٦٥
		winter	0.55 ± 0.23	0.027 ± 0.02	±١٤,٠٢ ١٦,٥٧
	Liver	summer	1.96 ± 0.55	0.171 ± 0 .105	±٢٧,٨٨٣ ١٠٩,٥٩
		winter	± ١,٠٩ ٠,٤٧	0.132 ± 0.152	±٣٢,٠٠٣ ٩٦,٧١
Random	Thigh	summer	1.38±0.404	0.144 ± 0.06	±١٧,٠٠٨ ٣١,١٣
		winter	1.55 ± 0.43	0.101 ± 0.06	±١٠,٢٦٢ ١٦,٤٩٤
	Liver	summer	2.2 ± 0.71	0.19 ± 0.08	±٥١,٩٦٣ ١١٨,١٧
		winter	2.06 ± 0.6	0.16 ± 0.062	±٤٢,١٠١ ١٢٢,٢٨
Imported	Thigh	summer	±٠,٩٧٢ ١,٦٩٣	±٠,٠٦٤ ٠,٠٥	±١٢,٤٩ ١٧,١٤
		winter	±٠,٣٩ ٠,٧٣٨	±٠,٠١٧ ٠,٠٣٢	١٢,٣٣ ±١٠,١

All values were tested at below the probability level ($P \leq 0.05$).

3.1. EDI (Estimated Daily Intake)

During the summer and winter seasons in Basra Governorate, children and adults may be exposed to heavy metals from consuming both local and imported sheep muscles, as shown in Table (2). We compared each group's total daily intake to the TDI of the different components, as set out by international organizations, in order to estimate the health risks associated with daily use. Lead (Pb), cadmium (Cd), and copper (Cu) all had EDI values greater than TDI, as is seen from the data. Lead EDI values in children's thighs from the imported slaughter source reached 1.851 mg/kg/d in the summer, while adults' thighs from the official slaughter source reached 0.257 mg/kg/d in the winter. Raising sheep in close proximity to public roads, contaminating drinking water and animal feed, and inundating soil with lead all contribute to the high EDI values for lead in the imported slaughter source. This may explain why Australian sheep have such high lead concentrations in their meat and organs. The summertime random slaughter source had the highest EDI values for cadmium in children, reaching 0.157 mg/kg/d. The acceptable limits for cadmium and lead, as defined by international organizations, are 0.01 and 0.0357, respectively, [33], [34], [35]. Contrary to the study [36] conducted on sheep muscles, this investigation found no such thing. Lead had an EDI value of 0.01 (µg/kg bw/day), whereas cadmium had an EDI value of 0.02. These are less than the permissible daily limit according to [33], [34] and [35]. The highest EDI values for copper were in the random slaughter source for children during the summer, reaching (34.035 mg/kg/d). The lowest value was in the official slaughter source during the summer for adults, reaching (5.116 mg/kg/d). The increase in copper values may be due to the food sources used as feed, which are usually fed to sheep and lambs. Which often include commercial supplements or some ingredients used in the manufacture of food supplements that may naturally contain a high percentage of copper, such as beet pulp, brewer's grains, corn distiller's grains, molasses, and soybean meal [37]. We note that the reason for the higher EDI values in children than adults is that children are particularly exposed to acute, subacute and chronic conditions resulting from the consumption of chemical pollutants. Because children eat twice as much food as adults do per kilogram of body weight, they may consume more of these harmful substances through their diet [38].

Table (2): EDI values of heavy metals for adults and children from sheep thigh tissue (gm/kg/d) in official, random, and imported slaughter sources

Source	Heavy metals EDI		Pb	Cd	Cu
Official	Adults	Summer	٠,٥٤٣	٠,٠٣٧	٥,١١٦
		Winter	٠,٢٥٧	٠,٠١٢	٧,٧٦٢
	Kids	Summer	١,٢٦٨	٠,٠٨٨	١١,٩٣٨
		Winter	٠,٦٠١	٠,٠٢٩	١٨,١١٢
Random	Adult	Summer	٠,٦٤٧	٠,٠٦٧	١٤,٥٨٦
		Winter	٠,٧٢٦	٠,٠٤٧	٧,٧٢٨
	Kids	Summer	١,٥٠٩	٠,١٥٧	٣٤,٠٣٥
		Winter	١,٦٩٤	٠,١١٠	١٨,٠٣٣
Imported	Adults	Summer	٠,٧٩٣	٠,٠٢٣	٨,٠٢٩
		Winter	٠,٣٤٦	٠,٠١٤	٥,٧٧٥
	Kids	Summer	١,٨٥١	٠,٠٥٤	١٨,٧٣٥
		Winter	٠,٨٠٩	٠,٠٣٤	١٣,٤٧٦
			0.0357 mg/kg/d	0.01 mg/kg/d	0.5 mg/kg/d

TDI : Tolerable Daily Intake consumption values according to international organizations	**-**FAO/WHO, 2010 -WHO, 2000 -FSA, 2006

3.2. Health Risk Assessment of Heavy Metals in Sheep Muscles (THQ)

In Basra city, both adults and children eat sheep (muscle) meat throughout the summer and winter, which might affect human health according to the Targeted Hazard Quotient (THQ). The non-carcinogenic hazards of the components under study were evaluated using it. Lately, a lot of academics have begun using this strategy to evaluate hazards. We have confirmed its legitimacy. Heavy metals provide a health risk when their THQ is more than 1, which means that ingesting food contaminated with the element is dangerous. Values less than 1 suggest a negligible danger to health [39]. We note from the results of Table (3) that all THQ values were less than 1.0 in the three sources during the summer and winter seasons for adults and children. That is, there are imperceptible or slight health risks when consuming sheep meat. Findings from this study corroborated those from the study by [40]. The THQ values of lead, cadmium and copper in sheep meat in Bosnia and Herzegovina were found to be less than 1.0. There is agreement between the findings of this investigation and an Egyptian study [41]. Muscle, liver, and kidney samples from both young and older sheep carcasses in Zagazig city had THQ values of cadmium (Cd) and lead (Pb) below 1.0. Therefore, eating these foods does not pose a carcinogenic risk.

Table (3): Health risk values (THQ) and (HI) values for heavy metals in thigh meat for both adults and children

Source	Heavy Metals THQ		**Pb**	**Cd**	**Cu**	**HI**
Official	Adults	summer	٠,١٥٥٢٩	٠,٠٣٧٩٥	0.36466	0.5579
		winter	٠,٠٧٣٦٣	٠,٠١٢٦٥	0.19405	0.28033
	Kids	summer	٠,٣٦٢٣٦	٠,٠٨٨٥٦	0.85088	1.3018
		winter	٠,١٧١٨1	٠,٠٢٩٥٢	0.45280	0.65413
Random	Adults	summer	٠,١٨٤٨٩	٠,٠٦٧٤٧	0.36466	0.61702
		winter	٠,٢٠٧٥١	٠,٠٤٧٣٢	0.19321	0.44804
	Kids	summer	٠,٤٣١٣٩	٠,١٥٧٤٤	0.85088	1.43971
		winter	٠,٤٨٤١٩	٠,١١٠٤٣	0.45083	1.04545
Imported	Adults	summer	٠,٢٢٦٦٥	٠,٠٢٣٤٢	٠,٢٠٠٧٣	٠,٤٥٠٨
		winter	٠,٠٩٩٠٦	٠,٠١٤٩٩	٠,١٤٤٣٩	٠,٢٥٨٤٤
	Kids	summer	٠,٥٢٨٨٦	٠,٠٥٤٦٦	٠,٤٦٨٣٨	١,٠٥١٩
		winter	٠,٢٣١١٦	٠,٠٣٤٩٨	٠,٣٣٦٩١	٠,٦٠٣٠٥

3.3. Elemental intake HI

Adults had HI values below 1.0 throughout the board, as seen in Table (3). This refers to the incidence of little negative health consequences. Consistent with our findings, a research on sheep meat in Bosnia and Herzegovina was carried out by [40]. All values of the risk index were less than 1.0. Our results conflict with those reached in the study [42] in Kuwait on sheep slaughtered in four central slaughterhouses. Where all values of HI for adults were greater than .01. This difference in the results can be attributed to the nature of the sheep's diet or the amount of exposure to heavy elements in the environment surrounding the farms from one country to another. As well as the difference in agricultural methods and practices and also due to the difference in techniques and tools used in analyzing the samples. As for the HI values for young animals, most of the values were greater than 1.0, where the highest value was in the random slaughter source during the summer and reached 1.43971. This indicates the occurrence of harmful (non-carcinogenic) health effects. However, the real concern lies in the possibility of these non-carcinogenic effects turning into carcinogenic effects upon chronic exposure to such elements [43].

4. Conclusions

When analyzing meat and liver samples, it was found that the average concentrations of lead in all liver samples exceeded the permissible limits. As for cadmium and copper, they were within the permissible limits. The levels of mineral elements were higher in the random slaughter source of local slaughter than in the imported slaughter source. The dumping of industrial or agricultural waste into waterways can contribute to the contamination of water used for irrigation or animal consumption and Animals that consume contaminated feed, such as feed contaminated with heavy metals or agricultural waste, can affect the level of mineral accumulation in sheep meat and liver ,Therefore, production and distribution methods must be improved and food control enhanced to reduce health risks, and Conduct further studies to identify heavy elements in parts and organs of sheep meat, such as shoulder, back, leg, bones, cerebrospinal fluid, blood, urine, heart and kidneys. Conduct further studies on heavy elements in other sources such as beef, poultry and fish.

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تقييم المخاطر الصحية للرصاص والكادميوم والنحاس في لحوم وكبد الأغنام المحلية والمستوردة في البصرة جنوب العراق.

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معلومات البحث

الاستلام 2 تشرين الثاني 2024
المراجعة 10 كانون الثاني 2025
القبول 2 شباط 2025
النشر 30 حزيران 2025

الكلمات المفتاحية

العناصر الثقيلة, المدخول اليومي المقدر للعناصر(EDI), المخاطر الصحية THQ مؤشر الخطر HI, لحوم وكبد, مدينة البصرة.

الملخص

تم جمع ٣٠٠ عينة من لحوم منطقة الفخذ واكباد الاغنام المحلية (للذبح الرسمي والعشوائي) والافخاذ المستوردة (الاسترالية) في مدينة البصرة خلال فصلي الصيف والشتاء, وقد بينت النتائج ارتفاع في متوسط تراكيز جميع العناصر المدروسة في مصدر الذبح العشوائي. كان أعلى متوسط تركيز للرصاص افي مصدر الذبح العشوائي للفخذ وللكبد في فصل الصيف (١,٣٨±٠,٤٠٤ و ٢,٢ ± ٠,٧١) ملغم/كغم على التوالي, وفي فصل الشتاء (١,٥٥ ± ٠,٤٣ و ٢,٠٦ ± ٠,٦) ملغم/كغم على التوالي, وكان أعلى متوسط تركيزللكادميوم في مصدر الذبح العشوائي للفخذ وللكبد في فصل الصيف كان (٠,١٤٤ ± ٠,٠٦ و ٠,١٩ ± ٠,٠٨) ملغم/كغم على التوالي, وفي فصل الشتاء (٠,١٠١ ± ٠,٠٦ و ٠,١٦ ± ٠,٠٦٢) ملغم/كغم على التوالي, بينما سجل أعلى متوسط تركيزللنحاس لمصدر الذبح العشوائي خلال فصل الصيف (١٧,٠٠٨± ٣١,١٣ و ٥١,٩٦٣± ١١٨,١٧) ملغم/كغم على التوالي, بينما بلغت خلال فصل الشتاء (١٠,٢٦٢± ١٦,٤٩٤ و٤٢,١٠١± ١٢٢,٢٨) ملغم/كغم على التوالي.. تم حساب المدخول اليومي المقدر من العناصر (EDI)ومقارنته مع المدخول اليومي المسموح به (TDI) ، وحاصل الخطرTHQ ، ومدخول العناصر (مؤشر الخطر) HI، للحوم الاغنام (الفخذ), وكانت جميع قيم (EDI) مرتفعة عن, (TDI) وكانت قيم THQ جميعها اقل من ١,٠ (<١) للبالغين والصغار, اي توجد مخاطر صحية وكانت طفيفة غير محسوسة للبالغين, لكنها كانت تقريبا محسوسة عند الصغار. وان قيم مؤشر الخطر HI كانت اقل من ١,٠(<١) للبالغين, اي أن المخاطر الصحية غير المسببة للسرطان قليلة جدًا, ولكن مؤشر الخطر HI للصغار كانت اكبر من ١,٠ (≤١) فهناك احتمال أن تحدث آثار صحية ضارة غير مسرطنة بعد استهلاك لحوم (الاغنام).

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