Tikrit Journal for Agricultural Sciences (2024) 24 (2): 311-327
DOI: https://doi.org/10.25130/tjas.24.2.22

ISSN:1813-1646 (Print); 2664-0597 (Online)
Tikrit Journal for Agricultural Sciences
Journal Homepage: http://www.tjas.org
E-mail: tjas@tu.edu.iq

TJAS
Tikrit Journal for Agricultural Sciences

Determine the levels of heavy metal residues in different parts of chicken in the Tikrit and Beji cities of Iraq

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KEY WORDS:
Heavy metal residues, Chicken parts, public health, and monitoring.

Received: 14/04/2024
Revision : 20/05/2024
Proofreading: 26/05/2024
Accepted: 22/06/2024
Available online: 30/06/2024

ABSTRACT

Food is the primary source of heavy metal exposure, hence assessing these metals in human dietary consumption is critical. This study aimed to determine the level of heavy metal residues in different parts of local chicken meat (thigh, bone, liver, and breast) obtained from various houses in the Iraqi cities of Tikrit and Beji. Heavy metal contamination in poultry products is a major concern due to its potential health effects on consumers. Samples were collected from local markets and analyzed for the presence of cadmium (Cd), copper (Cu), cobalt (Co), and lead (Pb) using atomic absorption spectroscopy (AAS). The results indicated that all chicken parts sampled contained detectable levels of heavy metals, with concentrations varying between parts. The high level of heavy metals cadmium (Cd) in the liver part in Tikrit was (0.422 ppm), also addition the high level of heavy metals copper (Cu) in L the liver part in Beji was (1.923 ppm), also the high level of heavy metals cobalt (Co) in the bone part in Tikrit was (1.403 ppm) and the high level of heavy metals lead (Pb) in the bone part in Tikrit was (1.045 ppm), indicating regional differences in contamination. These results emphasize the importance of monitoring heavy metal levels in different parts of chicken to ensure food safety and public health.

تحديد مستويات متبقيات المعادن الثقيلة في أجزاء مختلفة من الدجاج في مدينتي تكريت وبيجي في العراق

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الخلاصة

الغذاء هو المصدر الرئيسي للتعرض للمعادن الثقيلة، وبالتالي فإن تقييم هذه المعادن في الاستهلاك الغذائي البشري أمر بالغ الأهمية. هدفت هذه الدراسة إلى تقدير مستوى بقايا المعادن الثقيلة في أجزاء مختلفة من لحوم الدجاج المحلي (الفخذ، العظام، الكبد، والصدر) التي تم الحصول عليها من منازل مختلفة في المدن العراقية تكريت وبيجي. يعد التلوث بالمعادن الثقيلة في منتجات الدواجن مصدر قلق كبير بسبب آثاره الصحية المحتملة على المستهلكين. تم جمع العينات من الأسواق المحلية وتحليلها للتأكد من وجود الكادميوم (Cd)، والنحاس (Cu)، والكوبالت (Co)، والرصاص (Pb) باستخدام مطيافية الامتصاص الذري (AAS). أشارت النتائج إلى أن جميع أجزاء الدجاج التي تم أخذ عينات منها تحتوي على مستوى يمكن اكتشافه من المعادن الثقيلة، مع تباين التركيزات بين الأجزاء. كان المستوى العالي من الكادميوم المعادن الثقيلة (CD) في جزء الكبد في مدينة تكريت (0.422 جزء بالمليون)، بالإضافة إلى المستوى العالي من النحاس المعادن الثقيل (Cu) في جزء الكبد في مدية بيجي كان (1.923 جزء بالمليون)، وأيضًا المستوى العالي من بلغ مستوى المعادن الثقيلة الكوبالت (Co) في الجزء العظمي في تكريت (1.403 جزء بالمليون) وارتفاع مستوى المعادن الثقيلة الرصاص (Pb) في الجزء العظمي في تكريت كان (1.045 جزء بالمليون)، مما يدل على وجود اختلافات إقليمية في التلوث. تؤكد هذه النتائج على أهمية مراقبة مستويات المعادن الثقيلة في أجزاء مختلفة من الدجاج لضمان سلامة الغذاء والصحة العامة.

الكلمات المفتاحية: بقايا المعادن الثقيلة، أجزاء الدجاج، الصحة العامة، المراقبة او الرصد.

INTRODUCTION

Poultry meat is nutritionally valuable because it contains essential amino acids, vitamins, minerals, important trace elements, and antioxidants, all of which are beneficial for human health and growth, especially in developing countries (Amin *et al*., 2019; Hassanin *et al*., 2014; Majid *et al.*, 2020). Chicken meat and its edible offal, particularly livers, are extensively eaten in Iraq. (Majid *et al.*, 2020; Mawlood & Khidhir, 2018a; Jalal and Aziz, 2023), Since they can be incorporated into various culinary styles, including fast food, chicken meat and its edible offal, especially livers, are popular in Iraq. The liver, a vital organ, is crucial in metabolizing and detoxifying various substances, such as pharmaceuticals, harmful chemicals, microbial toxins, and heavy metals (Almazroo *et al.*, 2017). Every day, the contamination of heavy metals in food and feed is on the rise due to human activities in both industry and agriculture (Othman *et al.*, 2023). Poultry are subjected to a wide range of metals from polluted feed, water, and bedding, which can compromise the safety of their food products (Othman, 2023). Contamination of meat and meat products poses a significant public health risk, often resulting from inadequate handling, processing, and storage practices. Various contaminants, such as heavy metals, antibiotics, microorganisms, metabolites, mycotoxins, hormones, nitrates, nitrites, pesticide residues, dioxins, toxic pigments, and melamine, can compromise the safety of meat and meat products, potentially leading to human illness (Hu *et al*., 2018; Mawlood & Khidhir, 2018b; Mohammed and Ameen, 2023).

Heavy metal contamination in food and feed is on the rise due to human activities in industry and agriculture. Poultry are particularly at risk as they can be exposed to various metals through contaminated feed, water, and litter, compromising the safety of the food products they produce (Alperkhdri *et al.*, 2018; Khidhir, 2013). Heavy metal residues are identified by their lack of taste or odor, their long-lasting nature, their tendency to accumulate in tissues, their increase in concentration up the food chain, their various toxic effects, and their presence in meat and offal (Darwish *et al.*, 2018). Health institutions and organizations consider heavy metals in food a risk, establishing standard limits and monitoring programs to regulate acceptable levels of heavy metals in food (Albashr *et al.*, 2021; Andrée *et al*., 2010). Khidhir (2022) discovered that heavy metals tend to accumulate in varying degrees depending on the tissue and habitat location. Cadmium (Cd) and lead (Pb) are toxic non-essential metals known to accumulate in animal products. For example, lead in meat can be consumed by humans through digestion, which can interfere with the body's hemoglobin production and potentially inhibit various enzymes. Moreover, heavy metals can result in various harmful effects on biochemical systems, including issues with the heart, bones, kidneys, brain, liver, and nervous system (Ekhator *et al*., 2017). Regulation is necessary to monitor the quality of poultry and poultry products, aiming to enhance their quality for human consumption (Karim & Abdulla, 2024; Faraj, 2023; Khidhir, 2023).

This study aimed to determine the levels of heavy metal residues in various parts of local chicken (thigh, bone, liver, and breast) obtained from the Tikrit and Beji cities of Iraq.

MATERIALS AND METHODS

Study area and sample collection

One hundred twenty samples from various parts of local chicken (thigh, bone, liver, and breast) were obtained from various houses in the Tikrit and Beji cities of Iraq. The collected chickens were then directly transported to a higher education research laboratory, where different tissue parts were isolated after dissection. The samples were stored in clean polythene bags at 4 °C until further processing.

Sample preparation

Metal analysis was carried out using the previously described procedure (Sadeghi *et al*., 2015). Briefly, samples were cut into individual pieces, fully homogenized using a stainless-steel knife, and dried in an oven at 105°C for 12 hours or to get constant weights. Samples were ground to a fine powder in a kitchen mixer grinder to accelerate the digesting process. From each sample, three subsamples were selected for analysis.

Metal analysis

Ash was estimated in the samples by taking 10 gm of dried samples, and then the crucibles were placed inside a muffle furnace at 600 ºC for 18 hr. until a white or gray powder.

Heavy Element Estimation

After the samples were burned at 600 °C in a muffle furnace, the heavy metal concentrations in the samples were determined using atomic absorption. Nitric acid (15–20 mL) was added to 1 gm of removed ash in a 100 mL beaker to create a 1:1 (v/w) suspension before being covered with a watch glass. In a water bath (temperature 45°C), the mixture was heated until the ash dissolved and then cooled to room temperature (Sadeghi *et al*., 2015).

The samples were then quantitatively transferred to a volumetric flask with a 100 ml capacity, finished with distilled water, and used to create a model that was prepared for estimation by an atomic absorption spectrometer in the lab of the Department of Chemical Engineering at Tikrit University, the table 1 includes the λ_{max}, lamp current and slit for each element. Standard solutions: In a volumetric flask, intermediate standards were diluted with 1% nitric acid and kept in plastic bottles. The metal concentration was expressed as ppm.

Table 1: The λ_{max}, lamp current, and slit for each element.

Elements	λ_{max}	lamp current(mA)	Slit
Copper	324.8	6	0.7
Cobalt	240.7	12	0.2
Cadmium	228.8	8	0.7
Lead	283.3	10	0.7

Estimated Daily Intake (EDI)

Based on the observed mean concentrations of heavy metals in the different parts of chicken samples and the typical daily consumption of local chicken in the area, the estimated daily intake EDI values of the trace elements through consumption of the local chicken meat were calculated. To calculate the EDI (mg/kg/day), the following equation was used: EDI=Cm∗ADC/BW.

Where Cm is the mean concentration of metals in the chicken samples taken for this research, expressed as ppm of fresh chicken weight. ADC (g/person/day) is the average daily basis consumption of local chicken in the regions. BW is the body weight of the target population, 70kg (Bortey-Sam *et al.*, 2015).

A study conducted by the Food and Agriculture Organization (FAO) of the United Nations estimated that the average daily consumption of local chicken was 65.7 grams (Rossi *et al.*, 2018). Furthermore, because the target group typically consumes little liver, it was decided not to include it in the risk assessment in this survey.

Hazard Quotient (HQ)

The Hazard Quotient is a measure of the non-carcinogenic risks posed by consuming local chicken that contains traces of metals, which is the proportion of an environmental pollutant's estimated daily intake (EDI) to the reference oral dose (RfD), which is the expected lifetime daily intake of contaminants that people can tolerate.

The USEPA 1989 guidelines gave the following mathematical equation, which was used to calculate the HQ (Emergency & Response, 1989):

$$HQ=Cm*EF*ADC*EDRfD*bw*At*10^3$$

In this study, Cm represents the average metal concentrations in local chicken samples (measured in milligrams per kilogram on a fresh weight basis). EF stands for exposure frequency (365 days per year), ADC represents the average daily consumption of local chicken per person in the region (measured in grams per day), ED is the exposure duration (70 years), BW is the body weight of the target population, at is the average exposure time (calculated as ED multiplied by 365 days), and RfD stands for the oral reference dose (measured in milligrams per kilogram per day). The RfD (ingestion) values for Cd, Cu, Pb, Cr, Ni, and Co are 0.001, 0.04, 0.004, 0.003, 0.02, and 0.0003 (ppm bw/day), respectively.

If the HQ values are less than unity (1), it is unlikely that the exposure of the population to the pollutant will have evident negative effects. It was hypothesized that the combined effects of numerous contaminants would have an effect proportional to the exposed population.

Maximum allowable chicken consumption

The maximum permissible chicken consumption rate (CRlim, in kg/day) of contaminated chicken with a non-carcinogenic effect was calculated using the equation below: $CR\ lim$=RfD∗BW/Cm

Where CRlim is the maximum allowable chicken consumption rate (kg/day); RfD is the reference dose (ppm-day); BW is the consumer body weight (70 kg); and Cm is the concentrations of contaminant metals in a given poultry (ppm). (Bigler J. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories (1997).

Statistical analysis

The statistical analysis was conducted using the XL Stat application. Results for heavy metal determination were presented as mean ± standard deviation. A one-way analysis of variance (ANOVA) was employed to examine if there were significant differences in metal levels among different tissue parts and geographical locations. To assess significant variations between means, Duncan's multiple range tests were applied, with a significance level set at $P < 0.05$.

RESULT AND DISCUSSION

The concentration of Cd detected in the thing, bone, liver, and Brest samples collected from Tikrit and Beji province (Table 2) Cd concentration in the liver sample from Tikrit area was significantly higher ($P<0.05$) than in other areas and ascending order was Beji, the highest values recorded in Liver part from Tikrit was(0.422mg/kg). While the lowest value recorded in thigh parts from Beji was (0.164 ppm). The FAO/WHO Codex Alimentarius and the European Union have established a permissible limit of 0.5 ppm for cadmium (Cd) in chicken liver samples (Zhuang *et al.*, 2014). Also, Breast meat samples had Cd levels below the FAO/WHO Codex Alimentarius and European Union maximum allowed level of 0.3 ppm for poultry (Zhuang *et al.*, 2014). According to the Figure, all of the regions have an acceptable limit that is below (0.3 mg/kg) for

the Cd content according to the limit fixed by FAO/WHO Codex Alimentarius and the European Union. In contrast to this study, researchers in Turkey found that the Cd concentrations in chicken samples to be between 0.25 and 6.09 μg/kg (Vickers, 2017) while in Canada, it was between 1 and 2 μg/kg (Dabeka & Mckenzie, 1995), and in Nigeria, it was between 0.05 and 0.9 ppm (Onianwa *et al*., 2000). The data obtained from Table 2 observed that the Tikrit region had a higher Cd content (0.422 ppm) and the Beji region had a lower content (0.164 ppm). From the results, it could be observed that the Cd contamination was high in the liver samples collected. from local chicken in the Tikrit region but was within permissible quantity in thigh, bone, liver, and breast samples in local chicken collected from the rest of the region, indicating that all potential sources of Cd contamination, including feeds and the atmosphere, are relatively low (Jose *et al*., 2019).
Study of Khidhir (2023) in Sulaimani City, it was discovered that the cadmium (Cd) residues in both breast and liver samples from all regions were within the permissible limits set by the FAO/WHO (0.5 ppm for breast and 0.3 ppm for liver), except for the liver sample from the Dukan region, which exceeded the limit, recording a high value of 0.355 ppm.Accumulation of cadmium in the body can lead to kidney and reproductive system disorders. Exposure to cadmium may have happened through contact with cadmium-plated objects, garbage, paint, plastic, or electroplating wastes. The cadmium content in meat varied depending on the levels of cadmium in the diet and increased as the animal aged (Elsharawy & Elsharawy, 2015).

Table 2. Mean concentrations (ppm) of Metal (Cadmium Cd) Residue in Parts (Thigh, Bone, Liver, and Breast) Chicken at Tikrit and Beji mg/kg (mean ±SD).

Location	**Parts**			
	Thigh	**Bone**	**Liver**	**Breast**
Tikrit	0.223 ±0.000 bc	0.416 ±0.001 a	0.422 ±0.001 a	0.192 ±0.000 bc
Beji	0.164 ±0.000 h	0.309 ±0.000 c	0.232 ±0.001 d	0.177 ±0.001 g

Means with different superscripts in the same column are significantly different at (p≤0.05)

The concentration of Cu identified in the thing, bone, liver, and breast samples obtained from Tikrit and Beji provinces (Table 3) Cu concentration was substantially greater (P<0.05) in the liver sample from Beji compared to other regions, with Tikrit having the highest value (1.923

mg/kg). While the lowest value recorded in breast parts from Tikrit was (0.716 mg/kg). Copper (Cu) is widely present in our environment, occurring naturally and being used in various industrial and agricultural processes. It is necessary for several enzymes in the body, but excessive levels can lead to liver and kidney disorders (Elsharawy & Elsharawy, 2015). Copper (Cu) is resistant to breakdown in the environment, allowing it to accumulate in plants, animals, and soil. This accumulation poses a potential threat to public health when consuming animal products with high copper levels (Hu *et al.*, 2018). The results obtained in this study showed higher levels of copper compared to previous research (Jawad *et al.*, 2021) reported that copper concentrations in the liver and meat of chickens in Thi-Qar province, Iraq, ranged from 0.338 to 3.370 ppm, while (Ersoy *et al.*, 2020) found copper residues in chickens and their products near the cement industry to be between 0.332 and 2.489 ppm. Copper is essential for biological systems but can be harmful at higher levels. It enters the food chain through various routes, including industrial food processing, environmental contamination from agricultural inputs, metal-based industries, and the transfer of copper from contaminated soils to crops (Onianwa *et al.*, 2001).

The liver contains the highest concentration of heavy metals because it metabolizes all substances that enter the digestive tract, leading to exposure to toxic elements (Jawad *et al.*, 2021). In our investigation, we observed notable variations in heavy metal levels among different locations, which could be attributed to regional differences in poultry farming practices and dietary habits. Factors such as contamination of poultry feed and water, as well as conditions related to slaughter and sale locations, were identified as significant contributors to the elevated levels of heavy metals, particularly copper, in chickens from various regions (Ghimpeţeanu *et al.*, 2012).
However, the main reason for the rise in the concentration of copper heavy metal in chickens are the widespread use of chemical fertilizers in agriculture and industry in the Beji region. Study of Khidhir (2023), in Sulaimani city, The concentration of Copper (Cu) in breast meat and liver samples of all regions exceeded the permissible limit (1.0 mg/kg), levels proposed by FAO/WHO, and the highest concentration was detected in Dukan followed by Mergapan (11.541 and 11.372 ppm) respectively for liver sample.

Table 3. Mean concentrations (ppm) of Metal (Copper Cu) Residue in Parts (Thigh, Bone, Liver, and Breast) Chicken at Tikrit and Beji mg/kg (mean ±SD).

Location	Parts			
	Thigh	**Bone**	**Liver**	**Breast**
Tikrit	0.886 ±0.005 e	0.911 ±0.001 d	1.651 ±0.003 b	0.716 ±0.003 g
Beji	0.782 ±0.001 f	1.464 ±0.002 c	1.923 ±0.004 a	0.789 ±0.001 f

Means with different superscript in the same column are significantly different at ($p \leq 0.05$)

The concentration of Co detected in the thing, bone, liver, and breast samples collected from Tikrit and Beji province (Table 4) Co concentration in the bone sample from Tikrit area was significantly higher ($P<0.05$) than other areas and ascending order was Beji, the highest values recorded in bone part from Tikrit was (1.403 ppm). While the lowest value recorded in breast parts from Beji was (0.066 ppm). Cobalt is emitted into the environment through natural and human activities. It is an essential component of vitamin B12, yet excessive consumption can lead to negative impacts on the endocrine, nervous, and cardiovascular systems (Zahrana & Hendy, 2015). Cobalt is a crucial component of vitamin B12, which is vital to human health, and the presence of residual Co in liver samples showed that the liver is the site of Co metabolism. Cobalt found in the atmosphere at low enough concentrations to be considered safe for human exposure; however, toxic at high enough concentrations can enter food through processing or farming practices or metal-contaminated poultry feed, which can have harmful effects on human health at high enough exposure levels (Agade *et al.*, 2019).

Cobalt tends to accumulate the least among the metals studied, with the highest levels found in the liver and the lowest in the muscle. This indicates that cobalt does not undergo significant biomagnification in the food chain, resulting in relatively low concentrations of cobalt in meat (ATSDR, 2000). Study of Khidhir (2023), in Sulaimani city The mean concentration value of Cobalt in all studied regions for examined samples (liver and breast) were laid within the permissible limits (1.5 and 0.5 ppm) respectively set by FAO/WHO.

Table 4. Mean concentrations (ppm) of Metal (Cobalt Co) Residue in Parts (Thigh, Bone, Liver, and Breast) Chicken at Tikrit and Beji mg/kg (mean ±SD).

Location	**Parts**			
	Thigh	**Bone**	**Liver**	**Breast**
Tikrit	0.069 ±0.000 e	1.403 ±0.002 a	0.253 d±0.021	0.076 ±0.000 e
Beji	0.069 ±0.000 e	0.281 ±0.000 c	0.642 ±0.004 b	0.066 ±0.000 e

Means with different superscripts in the same column are significantly different at ($p \leq 0.05$)

The concentration of Pb detected in the thing, bone, liver, and breast samples collected from Tikrit and Beji province (Table 5) Pb concentration in the bone sample from the Tikrit area was significantly higher ($P<0.05$) than in other areas and ascending order was Beji, the highest values recorded in bone part from Tikrit was (1.045 ppm). While the lowest value recorded in breast parts from Beji was (0.044 ppm). Lead is recognized as one of the most harmful heavy metals, offering no advantages to animals or humans. Its presence in the environment is largely due to the widespread use of industrial products like batteries, leaded gasoline, limestone, and perfumes, as well as agricultural and sewage discharges (Ogwok *et al.*, 2014). Pb can accumulate in the liver and bones as well as affect the nervous, hematopoietic, reproductive, cardiovascular, and adrenal systems (Khan *et al*., 2016). whom reported that the concentration of lead in the breast and liver of frozen chicken meat imported in Tikrit markets were (1.52 and 3.74 ppm) respectively. The primary origins of lead in the environment stem from common industrial activities involved in the production of perfumes, batteries, oils and fats, cement, and bricks. Additionally, agricultural runoff, sewage discharges, traffic emissions, and mining operations contribute to environmental lead contamination. Improper disposal of industrial waste, which includes releasing pollutants into various environmental components such as air, land, water, and food, has led to the poisoning of numerous individuals and animals (Humphreys, 1991).

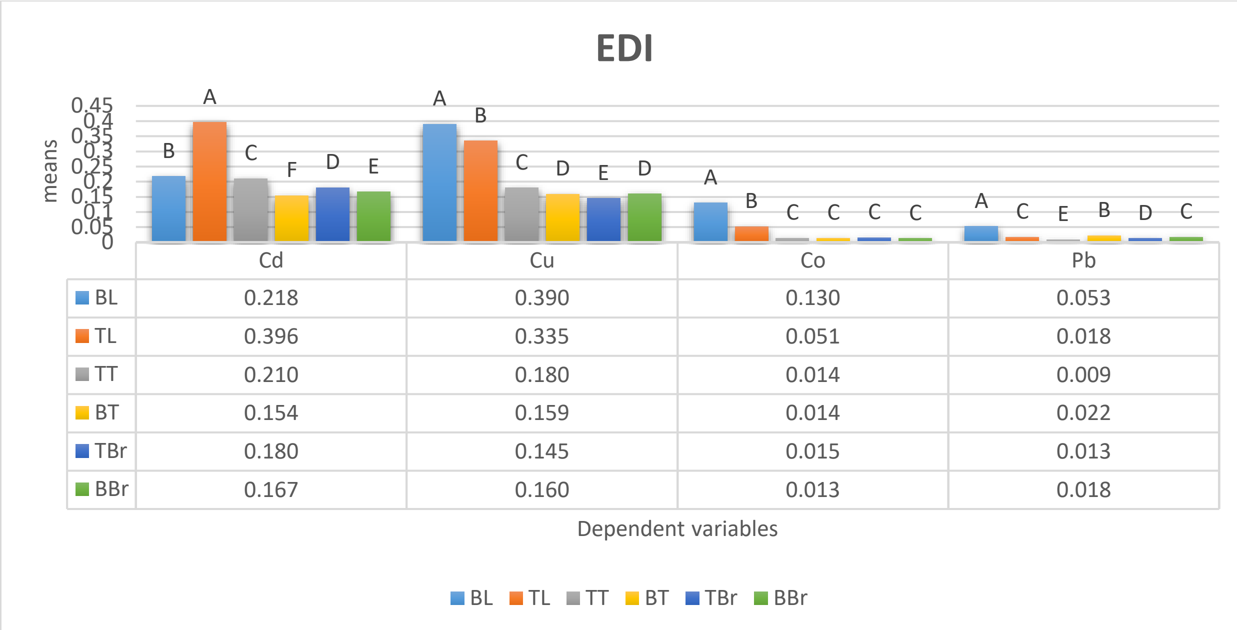
Study of Khidhir (2023), in Sulaimani City The mean value of lead (Pb) residue was found exceeding the permissible limit levels of 0.1 ppm in the liver samples of all the regions (0.147–0.729 ppm), except for Mergapan which recorded low value (0.091 ppm). Concerning Pb concentration in the breast sample the value from Dukan and Tanjaro (0.118 and 0.149 ppm) respectively exceeded the permissible limit, while from Bazyan and Mergapan (0.082 and 0.022) respectively, the value was within permissible limit.

Table 5. Mean concentrations (ppm) of Metal (Lead Pb) Residue in Parts (Thigh, Bone, Liver, and Breast) Chicken at Tikrit and Beji mg/kg (mean ±SD).

Location	**Parts**			
	Thigh	**Bone**	**Liver**	**Breast**
Tikrit	0.044 ±0.000 g	1.045 ±0.001 a	0.087 ±0.000 e	0.065 ±0.000 f
Beji	0.109 ±0.000 d	0.836 ±0.001 b	0.261 ±0.000 c	0.087 ±0.000 e

Means with different superscript in the same column are significantly different at ($p \leq 0.05$)

The obtained results in this study showed that the estimated daily intake for consumption of heavy metals in the tested regions was as follows; for Cd, the range was (0.167- 0.218 ppm /day), for Cu the range was (0.160-0.390 ppm /day), for Co the range was (0.013- 0.130 ppm /day) and finally for Pb the range was (0.018-0.053 ppm /day). Eating different parts of chickens from Tikrit and Beji regions was studied, and the levels of heavy metals consumed were found to be lower than the recommended daily intake limits. This indicates that consuming local chickens from all regions studied does not pose a health risk from the ingestion of the examined heavy metals. Similar findings were reported by (Al-Bratty *et al.*, 2018) in their analysis of heavy metals in various tissues of locally reared (Baladi) chickens in the Jazan Region of Saudi Arabia, as well as by (Naseri *et al.*, 2021) in their study on the health risk assessment of Cd, Cu, Co, and Pb in the muscle, liver, and gizzard of hens marketed in the east of Iran.



	Cd	Cu	Co	Pb
BL	0.218	0.390	0.130	0.053
TL	0.396	0.335	0.051	0.018
TT	0.210	0.180	0.014	0.009
BT	0.154	0.159	0.014	0.022
TBr	0.180	0.145	0.015	0.013
BBr	0.167	0.160	0.013	0.018

Figure 1 Estimated daily intake (EDI - mg/kg/day) of heavy metals in Parts (Thigh, Bone, Liver, and Breast) of local Chicken at Tikrit and Beji

The aim of risk assessment is to ascertain the probability of harmful health effects resulting from exposure to a contaminant at a specific dose through various exposure routes. Target hazard quotients (THQ) were employed to assess the non-carcinogenic risks linked to meat consumption in adults. THQ represents the ratio of the actual pollutant dose to a standard dose. A ratio exceeding 1 suggests that the exposed population may experience significant adverse effects (Wang *et al.*, 2005). The estimated THQ of studied heavy metals is shown in Figure 2. The calculated Target Hazard Quotient (THQ) values for each metal were below 1 across all regions analyzed, indicating that there is little risk of harm to the target population from exposure to these toxic elements through the intake of meat from local chickens. The highest THQ values for Cd (0.010) were observed in Tikrit, while the lowest values (0.004) were observed in Beji. The highest THQ values for Cu (0.390) were observed in Beji while the lowest values (0.145) were observed in Tikrit. The highest THQ values for Co (0.033) were observed in Beji, while the lowest values (0.003) were observed in Tikrit and Beji .and the finale The THQ values for Pb less than (0) were observed in Tikrit and Beji. All THQ values were found to be below one, indicating that consuming individual heavy metals through the consumption of local chickens would not pose significant health risks. This finding is consistent with previous research conducted by (Al-Bratty *et al.*, 2018) on heavy metal levels in locally reared (Baladi) chicken in the Jazan region of Saudi Arabia.

However,(Naseri *et al.*, 2021) found a similar result when conducting a health risk assessment of heavy metals in the muscle, liver, and gizzard of marketed hens in the east of Iran.

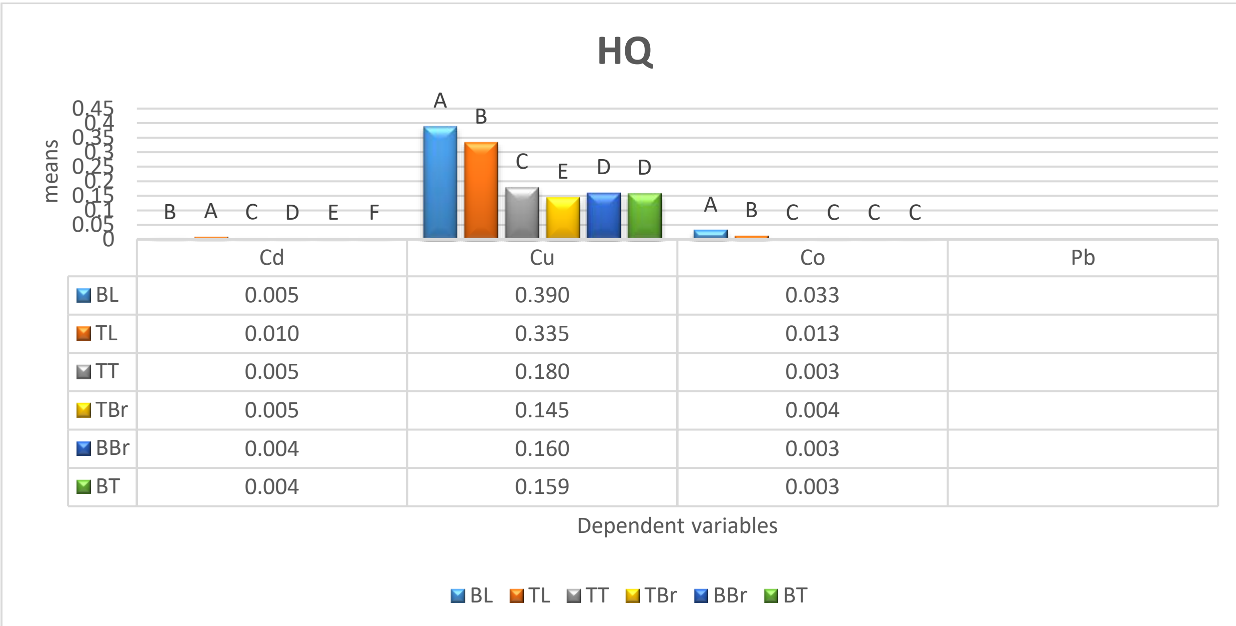
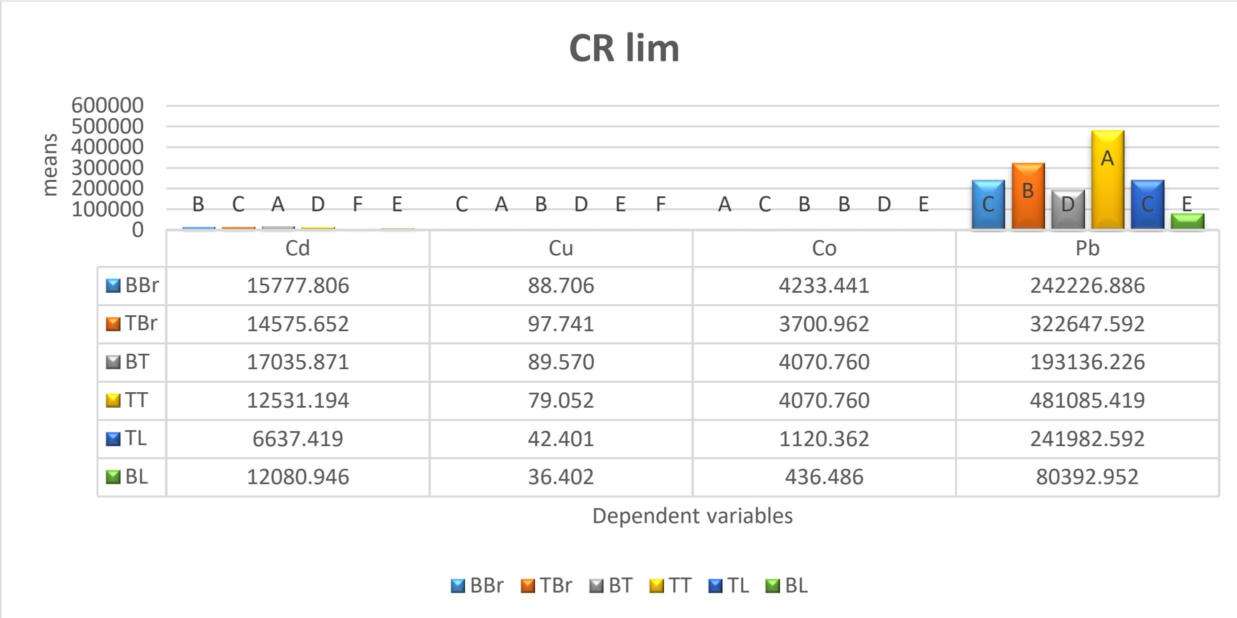


Figure 2: Health risk assessment data (HQ) for heavy metal in Parts (Thigh, Bone, Liver, and Breast) of local Chicken at Tikrit and Beji

Maximum allowable chicken consumption **(**$CR\ lim$)The maximum allowable local chicken consumption (CRlim) for elements in this study is presented in Figure 3. The highest risk of Cadmium was detected when consumption of local chicken thighs from the Beji region (17035.871). In connection with Cupper, the highest risk was recorded when the consumption of local chicken breast from the Tikrit region (97.741). As for cobalt, the risk was the highest when the consumption of local chicken breast from the Beji region (4233.441). Finally, the risk of lead was the highest when the consumption of local chicken breast from the Tikret region (481085.419). The results obtained in this study showed the maximum allowable local chicken consumption (CRlim) for elements. The highest risk of Cadmium was detected when consumption of local chicken breast from Bazyan region (7.694 kg/day). Connection with Cupper, the highest (Khidhir, 2023).



	Cd	Cu	Co	Pb
BBr	15777.806	88.706	4233.441	242226.886
TBr	14575.652	97.741	3700.962	322647.592
BT	17035.871	89.570	4070.760	193136.226
TT	12531.194	79.052	4070.760	481085.419
TL	6637.419	42.401	1120.362	241982.592
BL	12080.946	36.402	436.486	80392.952

Figure 3: Maximum allowable chicken consumption ($CR\ lim$) for heavy metal in Parts (Thigh, Bone, Liver, and Breast) Chicken at Tikrit and Beji

CONCLUSION

This study indicates that the concentrations of heavy metals vary based on the region and specific poultry parts, underscoring regional disparities in contamination levels. Another study needs to estimate the heavy metals concentration in feed and environment of poultry houses. These results underscore the necessity of monitoring heavy metal residues across different chicken parts to guarantee food safety and safeguard public health.

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