Article

Study of The Chemical Composition and Heavy Metals Levels Determination in The Muscles of Local Cows in Shirqat City

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Abstract

The researchers looked at the heavy metals (copper, cadmium, lead, and zinc) and the amounts of moisture, protein, fat, and ash in the muscles (femoral muscle, liver, dorsal muscle, and kidney) of male and female cows bought at Shirqat city markets between February 10, 2023, and March 2, 2023.

The findings indicated that the liver of male cows exhibited the highest moisture content at 74.83%, whereas the kidneys of male cows displayed the lowest moisture content at 70.12%. The femoral muscle in both male and female cows had the highest protein levels, recorded at 19.83% and 19.87%, respectively, while the liver of male and female cows showed lower protein levels at 12.92% and 12.04%, respectively.

The fat percentage reached its peak at 11.84% in the dorsal muscle of male cows, whereas the lowest fat percentage was recorded at 4.82% in the liver of male cows.

The ash levels exhibited no significant differences, with the highest value (1.10%) observed in the female femoral muscle. There was also a significant ($p<0.05$) effect on the heavy metal levels in the femoral muscle, liver, dorsal muscle, and kidney of both male and female cows when the three study factors interacted with each other.

The study indicates a significant effect of sex and muscle location on copper levels, with the highest copper concentration (2.72 ppm) found in the livers of male cows. On the other hand, sex did not have a big effect on the low levels of lead found in all samples, and there were also no significant differences in the amounts of any element found in the meat muscles across all samples.

Zinc levels were elevated in all meat samples, with the maximum concentration of 112.55 ppm found in the liver of female cows, above the allowed limit of 50 ppm.

Keywords: Heavy Metals, Cadmium, Muscles of cows

Introduction

The demand for meat and its derivatives has escalated over the past two decades, exhibiting consistent growth in numerous regions, including Africa, Asia, Europe, and the United States. Consequently, there has been a pressing necessity for the swift expansion of animal husbandry and meat production to ensure food security in these nations (Al-Zalaki, 2001).

The significance of meat and auxiliary organs is attributed to two primary causes. The primary objective is to address the nutritional deficiency of animal proteins essential for humans while also serving as a significant contributor to economic development and food policy in nations. In South Africa, byproducts from the slaughter of livestock constituted 10–15% of the total live animal products.

After slaughter, living products make up about two-thirds of the carcass (Alao et al., 2017), Meat and its by-products provide various essential and crucial nutrients that cannot be obtained from plant sources.

Consequently, global focus shifted to meat by-products, anticipated to bridge the disparity significantly between production and nutritional requirement (i.e., compensating for the lack of protein by relying on meat by-products), These include a variety of essential components such as protein, minerals, and fats, especially unsaturated fatty acids.

Alongside amino acids analogous to those present in animal muscle tissue, it also comprises other vitamins like (B1, B2, B6) (Rosa et al., 2002)

Research on the secondary organs of animals as a food source in the Arab world and Iraq is limited, mostly focusing on the production of some traditional dishes, their nutritional and aesthetic acceptability, and heavy metal contamination.

The study's goal is to look at the chemical make-up and level of mineral contamination in the femoral, dorsal, liver, and kidney muscles of Shirqat city cows, both male and female.

Materials and procedures

Samples

The research was performed in the Division of Food Sciences at the University College of Agriculture of Tikrit. Samples were obtained from the local meat markets in Shirqat city from February 10, 2023, to March 2, 2023.

The investigation encompassed the femoral muscle, liver, dorsal muscle, and kidney. The samples were promptly transferred to the laboratory post-slaughter, stored in a plastic container, and placed in the home freezer at a temperature of -18°C until laboratory analyses were performed.

3.2. Qualitative tests:

3.2.1. Determination of humidity

Relative humidity in meat samples was determined using A.O.A.C. Method (2004) with a specified weight, crushed to 10 grams, placed in an aluminum metal container and dehydrated in an electric oven at 105°C until constant weight, with three replicates..

3.2.2. Determination of fat

Following the procedure outlined in A.O.A.C. (2004), we used Soxhlet extractors to determine the fat content of meat samples. We started with a known weight of dried meat and extracted it using diethyl ether solvent. There were three separate analyses that determined the fat content..

3.2.3. Determination of protein

The total nitrogen content of the meat was estimated according to the method specified by A.O.A.C. (2004). To do this, the samples were digested with concentrated sulfuric acid, the mixture was distilled using boric acid and a bromocresol green guide, and then the mixture was washed with 0.1N hydrochloric acid using a conversion factor of 6.25. This process was carried out to determine the percentage of protein present in the samples derived from secondary organs.

% of protein = N (nitrogen x 6.25) Dalali and Hakim (1987).

3.2.4. Determination of Ash

The ash content in the analyzed meat was determined by weighing 2 g of the meat in a ceramic dish of known mass, which was subsequently placed in an incineration oven at 600°C until a stable weight was achieved, resulting in a white or gray powder. Once the incineration was complete, we adjusted the lids and secured the weights using the following equation.

Ash weight = weight of empty lid + weight of sample before incineration - weight after incineration

Ash percentage = ash weight / sample weight x 100

3.2.5. Determination of mineral elements

Mineral elements were estimated in the studied meat muscles, which included six elements, according to the methodology used (A.O.A.C, 2004) inside the main lab's atomic absorption apparatus - Tikrit University. As well as the Department of Chemical Engineering. College of Engineering, Tikrit University.

4.1. Chemical composition of the studied organs

Table (1) The investigated substance's chemical make-up meat organs

Parameter	Sex effect	Type of muscle meat				Mean sex
		Femoral	Liver	Dorsal muscle	Kidney	
Moisture	Male	0.52 ± 71.82 b	1.20 ± 74.83 a	0.54 ± 71.80 b	0.23 ± 70.32 b	0.68 ± 72.19 A
	Female	0.03 ± 70.36 b	0.08 ± 74.44 a	0.50 ± 71.61 b	0.01 ± 70.12 b	0.66 ± 71.63 A
	Mean muscle meat type	0.47 ± 71.09 BC	0.50 ± 74.64 A	0.30 ± 71.70 B	0.11 ± 70.22 C	
Protein	Male	0.46 ± 19.92 a	0.63 ± 12.92 d	0.49 ± 12.92 d	0.04 ± 15.06 c	1.09 ± 15.20 A
	Female	0.02 ± 19.83 a	0.71 ± 12.04 d	0.73 ± 15.28 bc	0.26 ± 16.80 b	1.08 ± 15.98 A
	Mean muscle meat type	0.19 ± 19.87 A	0.46 ± 12.48 D	0.77 ± 14.10 C	0.51 ± 15.93 B	
Fat	Male	0.02 ± 7.02 cd	0.12 ± 6.53 d	0.41 ± 11.84 a	0.52 ± 4.82 e	0.99 ± 7.55 B
	Female	0.08 ± 7.65 c	0.01 ± 7.23 cd	0.06 ± 6.59 d	0.12 ± 10.33 b	0.54 ± 7.95 A
	Mean muscle meat type	0.18 ± 7.33 BC	0.21 ± 6.88 C	1.52 ± 9.22 A	1.61 ± 7.57 B	
Ash	Male	0.06 ± 0.93 b	0.02 ± 1.00 ab	0.02 ± 0.92 b	0.00 ± 0.93 b	0.02 ± 0.94 A
	Female	0.11 ± 1.10 a	0.03 ± 0.99 ab	0.01 ± 0.87 b	0.02 ± 0.95 ab	0.04 ± 0.98 A

	Mean muscle meat type	0.07 ± 1.01 A	0.01 ± 0.99 AB	0.02 ± 0.90 B	0.01 ± 0.94 AB	

The findings show the chemical composition of muscle tissues in male and female samples (Table 1-4). The study included femoral muscle, liver and back muscle. The findings of this study showed that the triple interaction between the components significantly affected the moisture content. Significant differences were observed, with the maximum moisture content of 74.83% in the liver of males, while the minimum moisture content of 70.12% was observed in the whole female.

The results showed that gender did not have a significant effect on the muscle moisture content. However, the muscle type showed a significant difference in moisture levels, with the liver reaching the highest moisture content of 74.64%.

The findings of this study showed that the triple interaction between parameters greatly affected the protein content in the analyzed beef muscles. Muscle type showed significant variations, with the femur muscle reaching the highest protein content of 19.92% in bulls and 19.83% in cows.

We did not detect any significant differences in protein percentage based on gender. The results of the study showed that the type of muscle studied significantly affected the protein percentage, with the maximum protein content of 19.87% in the femur muscle and the lowest with 12.84% in the liver muscle.

The results of the study showed that the parameters studied significantly affected the fat level, with the back muscle showing the highest fat percentage with 11.84%.

Gender showed a significant difference in fat percentage, with females showing the highest figure with 7.95%. The muscle type component greatly influenced the fat percentage, with 9.22% recorded in the back muscle.

Muscle position significantly influenced the ash reading. The study showed that the femoral muscle of the female cow had the highest ash percentage (1.10%). However, gender did not significantly influence the mean ash percentage. Muscle type significantly influenced the ash content (1.01%) in the normal femoral muscle..

The reason for this can be attributed to the fact that the chemical composition of the meat is influenced by the sex of the animal, the location of the muscle and the nature of the diet. These results are consistent with those obtained by (Tajik, 2012), and these results are consistent with those stated by the United States Department of Agriculture (USDA, 2017) that the moisture content reached 71.37%, fat 5.2% and protein 20.38% in beef liver..

4.2. Assessment of heavy metal concentrations in the analyzed beef tissues

Table (2) The concentration of heavy metals in the musculature of the examined cattle

Elements	Sex	Type of muscle meat				Mean sex
		Femoral	Liver	Dorsal muscle	Kidney	
Copper	Male	0.02 ± 0.56 de	0.07 ± 2.72 a	0.02 ± 0.61 cd	0.02 ± 0.57 de	0.35 ± 1.11 A
	Female	0.02 ± 0.59 cde	0.00 ± 0.74 b	0.06 ± 0.70 bc	0.03 ± 0.46 e	0.04 ± 0.62 B
	Mean muscle meat type	0.01 ± 0.57 BC	0.57 ± 1.73 A	0.04 ± 0.66 B	0.03 ± 0.51 C	
Lead	Male	0.02 ± 0.06 a	0.00 ± 0.05 a	0.00 ± 0.01 c	0.00 ± 0.01 c	0.01 ± 0.03 A

	Female	0.00 ± 0.05 a	0.01 ± 0.03 bc	0.00 ± 0.01 c	0.01 ± 0.04 ab	0.01 ± 0.03 A
	Mean muscle meat type	0.01 ± 0.05 A	0.01 ± 0.04 B	0.00 ± 0.01 C	0.01 ± 0.02 C	
Cadmium	Male	0.01 ± 0.13 A	0.01 ± 0.16 A	0.01 ± 0.18 A	0.01 ± 0.15 A	0.01 ± 0.15 A
	Female	0.05 ± 0.17 a	0.01 ± 0.20 a	0.03 ± 0.19 a	0.00 ± 0.18 a	0.01 ± 0.18 A
	Mean muscle meat type	0.02 ± 0.15 a	0.01 ± 0.18 a	0.01 ± 0.18 a	0.01 ± 0.17 a	
Zinc	Male	0.23 ± 53.77 cd	2.43 ± 79.42 b	0.99 ± 35.46 e	2.86 ± 62.09 c	6.02 ± 57.68 A
	Female	0.53 ± 32.84 e	±112.55 12.45 a	1.48 ± 42.45 de	1.77 ± 62.08 c	± 62.48 11.87 A
	Mean muscle meat type	6.05 ± 43.31 C	± 95.99 10.88 A	2.14 ± 38.95 C	1.37 ± 62.08 B	

The results of heavy metal levels in beef muscles (thigh, liver, back muscle and kidney) in male and female cattle studied are shown in Table (2-4).

The study showed that the things looked at had a significant effect on the mineral element levels, with muscle type showing the greatest effect ($p<0.05$). All female cattle studied had the highest copper concentration (0.46ppm).

The average gender had a significant effect on copper levels (1.11ppm) in male muscles and the average muscle had a significant effect on copper levels (1.73ppm) in the liver of the cattle studied.

The findings are consistent with Rickwatt's (2021) study on the effect of muscle location on copper concentration, which showed that the liver showed the highest copper levels compared to other organs in goat meat. Muscle location significantly affected lead concentration, with the highest values recorded at 0.06 and 0.05 ppm in the femur muscle and liver of male subjects, respectively. Conversely, the device failed to detect lead concentration in the femur muscle of female subjects and the dorsiflexor muscle of male and female subjects..

Furthermore, WHO (2007) showed that the lead results were acceptable. The effects of the factors studied, namely muscle location, gender and mean beef muscle type, respectively, had no significant effect on cadmium element values in all the samples studied and the results obtained were above the international permissible limit of not exceeding (0.050 ppm) (FAO 20).

The study showed a significant effect on zinc concentration (112.55 ppm) in the liver of female cattle, while gender had no effect on zinc levels. The mean muscle type of meat had a significant effect on zinc concentration (95.99 ppm) in all meat samples examined, with the highest zinc levels in beef liver (0.125 ppm). These zinc levels exceed the international permissible limit of 50 ppm (Hameeda, 2000).

Conclusion

The research examined heavy metals (copper, cadmium, lead, and zinc) and nutritional constituents (moisture, protein, fat, and ash) in the musculature of male and female cattle from markets in Shirqat city. The findings indicated that male cow livers exhibited the highest moisture content at 74.83%, whereas kidneys displayed the lowest at 70.12%. The femoral muscles demonstrated the highest protein concentrations (19.83% for males and 19.87% for females), whereas the liver revealed lower concentrations (12.92% for males and 12.04% for females). The fat content reached a maximum of 11.84% in male dorsal muscles and was minimal in male livers at 4.82%. Copper concentrations were markedly influenced by sex and muscle location, with the highest levels observed in male livers (2.72 ppm). Lead concentrations were uniformly low across samples, with no significant variations. Zinc concentrations surpassed the allowable threshold, attaining 112.55 ppm in the livers of female cows.

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