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# NUTRITIONAL COMPOSITION AND QUALITY OF *CAMELUS DROMEDARIUS* MEAT FROM BUTCHERIES IN NOUAKCHOTT, MAURITANIA

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## ABSTRACT

The camel is an animal adapted to life in the desert and plays a vital social and economic role. In Mauritania, people usually like camel meat more than any other kinds of meat. This preference is due to the high quality (rich in protein) and low price of camel meat compared with other meat in these areas. Dromedary meat, which is generally comparable to that of beef, presents undeniable dietary advantages due to its low cholesterol content, and its relative richness in fatty acids, vitamins, trace elements and calcium. In this work we studied the nutritional quality of camel meat in Mauritania, by determining the content of proteins, lipids, ash, moisture and essential trace elements (iron, copper and zinc). Meat samples were collected randomly from butcheries located in Nouakchott city between February and April 2020. Samples were dried and analyzed according to established method. The nutritional value of camel meat was found to be similar to that of beef in terms of protein and fat content. However, a significant moisture content exists in younger animals (72.992%), which decreases in older camels (71.284%). Meat is composed of a high protein content, almost 18.8% protein; a lipid content varying according to age, from 1.53 to 4.26% and an ash content, more or less equal for all ages (0.90 to 1.1%). Liver had the highest level of protein, and the highest level of lipid was detected in muscle. Ash content didn't have an important variation between organs. Protein, lipid and ash contents had the following order: Protein>lipid>ash. Iron content ranged from 0.80 mg/100g to 6.02 mg/100g, while copper and zinc levels varied across organs. Copper levels show a significant correlation with age, particularly in the kidney and muscle. Copper and Zinc are more concentrated in Liver and muscle than kidney, however; Irons content is very important in kidney. Essential metals concentrations have the order: Iron>Copper>Zinc

**Key words**: *Camelus dromedarius* meat, nutritional quality, protein content, iron, copper, zinc, Nouakchott, Mauritania

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## INTRODUCTION

The dromedary meets multiple needs of populations by providing them with milk and meat, while also serving as a means of transport [1]. Camel meat is a primary source of nutrition in Arabian, African, and some Asian countries, particularly in hot climates [2]. In these regions, camel meat products are considered an essential part of the cuisine, especially during family and religious celebrations [3]. Mauritania, a West African country, has the largest camel population in the region, estimated at over 1.5 million [4]. This figure ranks it 6th globally. Camel breeding is practiced throughout the national territory [1].

Dromedary meat is rich in essential amino acids [5,6] and is generally comparable to beef in terms of protein content. It offers significant dietary advantages, particularly due to its low cholesterol content (50–61 mg/100g), especially compared to other meats such as sheep (53–78 mg/100g), chicken (57–76 mg/100g), and beef (59–73 mg/100g) [7]. The nutritional value of camel meat is also noteworthy, particularly due to its beneficial fatty acid composition [8]. The nutritional quality of camel meat has been extensively studied in some Middle Eastern countries. However, research on camel meat in Mauritania remains recent, which explains the limited information available on the subject.

Mauritanians generally prefer camel meat over other types of meat [9]. This preference is attributed to its high protein content and lower price compared to other meats, such as beef and mutton, in the region [3,10]. Proteins and certain lipids are essential in the human diet, with meat serving as an important source of both. While fat provides energy, excessive lipid intake may be nutritionally undesirable. Many minerals are essential for humans, and meat is a key source of several important minerals, including iron and zinc. Notably, potentially harmful minerals are generally absent in camel meat [9].

Camel meat plays a central role in the daily diet of Mauritanians, where it is rarely processed but often preserved through traditional methods such as drying, salting, and smoking. The growing interest in camel meat, particularly red camel meat, reflects a recognition of its nutritional and dietary value [5,6]. Given its importance, this study aimed to analyze the nutritional quality of camel meat by examining its protein, lipid, ash, and moisture content, as well as key trace elements (Fe, Cu, Zn), taking into account the influence of age on its nutritional composition.

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## MATERIALS AND METHODS

### Sample Collection

Dromedary meat was randomly collected from several butcheries in Nouakchott, Mauritania, between February and April 2020. Immediately after collection, the samples were transported to the laboratory on ice to maintain freshness. Two groups of age are targeted (3 years and more than 5 years). A total of ten camel meat samples were processed, with three replicates per sample. Each sample consisted of three organs: liver, muscle, and kidney.

### Sample Preparation

In the laboratory, individual samples (20 ± 3 g of liver and kidney, and 45 ± 5 g of muscle) were separately dried to a constant weight at −46 °C for 48 hours using a lyophilizer system in acid-washed flasks. Moisture content was calculated, and the dried samples were ground into a fine powder using a porcelain mortar and pestle.

### Analyses

Analyses were conducted according to the following methods:

**Protein**: AOAC, 2001.11, 18th édition, Rév.4, 2011

The sample is mineralized through acid digestion with sulfuric acid in the presence of a catalyst, followed by alkalization of the reaction products. The released ammonia is distilled and absorbed in a boric acid solution, then quantified by titration with a sulfuric or hydrochloric acid solution. The nitrogen content is determined, and the protein content is calculated using the conventional conversion factor of 6.25.

**Ash:** NF V 04-404:2001

The sample is heated to a high temperature (generally between 500 and 600°C) in a muffle furnace. This combustion removes all organic matter in the form of gases ($CO_2$, $H_2O$, etc.), while the inorganic mineral residues remain as ash.

**Fat:** NF V 04-403:2001

The method involves extracting the total lipids from the sample using petroleum ether (60-40) in a Soxhlet apparatus. After extraction, the organic phase is evaporated, and the lipid residue is subsequently dried and weighed to determine the lipid content.

**Iron, Zinc and Copper**: MA.200. Mét.1,2

Samples of 0.2 g dry weight (dw) were digested by duplicate. Samples were placed in microwave-closed vessels with a mixture of ultra-pure nitric acid 67% and hydrogen peroxide 30% (3:1) at room temperature for 1 h, then they were extracted by microwave [9]. Digestion conditions applied in the microwave system were as follows: 3 min at 250 W; 5 min at 650 W; 22 min at 500 W and finally 5 min at 0 W and vent. Hydrogen peroxide with nitric acid was added to the samples because

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peroxide decreases nitrous vapors and speeds up the digestion of organic substances by elevating the reaction temperature. Then the digested samples were diluted to 20 mL with deionized water (Milli-Q quality).The trace metal analysis was conducted using Indicative Plasma Couple-optic emission specter (ICP-OES), which limit of detection (LOD) is 0.005 mg/kg

### Statistical Analysis

Nutrient concentrations were initially expressed as mean ± standard deviation for each organ and food type. Since data were collected multiple times from the same individual (liver, kidney, and muscle), linear mixed-effects models were used to assess the significance of differences in nutrient concentrations both between nutrients and between organs.

When significant differences were detected, Tukey post hoc tests were conducted to identify which specific organs differed and to quantify the magnitude of these differences. Normality was tested using the Shapiro-Wilk test. A significance level of $p < 0.05$ was applied for all statistical comparisons.

All statistical analyses and figure generation were performed using R software (version 4.0.1) [20].

## RESULTS AND DISCUSSION

Table 1 presents the global mean and standard deviation of nutrient concentrations in each organ.

### Moisture Content

A difference in average moisture content was observed between organs; however, age had no significant effect on moisture levels. The kidney exhibited the highest moisture content (80.57 ± 1.54%), while the liver had the lowest (68.36 ± 2.20%). The muscle contained 74.39 ± 2.61% moisture. The water content in camel meat, which ranges between 70% and 77%, is consistent with previous studies [6, 11, 12]. This high moisture content is influenced by several factors, including breed, sex, individual variation, age, health status, diet, and slaughter conditions [12]. Due to its high moisture content, camel meat is highly perishable and requires adequate preservation to prevent spoilage.

### Essential Nutrients

Statistical analysis revealed significant differences in nutrient concentrations across different organs ($p = 0.0123$ for ash, $p < 0.0001$ for protein and fat). However, no significant differences were found based on food type or camel gender ($p > 0.05$ in all cases).

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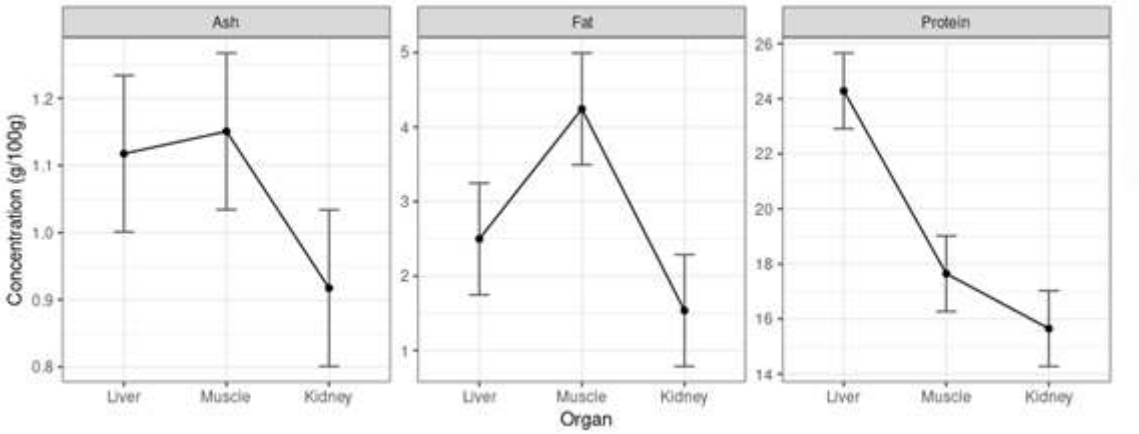


**Figure 1: Main Nutrient Concentrations by Organ**

## Ash Content

The mineral matter (ash) content varied among the three analyzed organs. The liver exhibited the highest ash concentration (1.19 g/100 g), followed by the muscle (1.131 g/100 g), while the kidney had the lowest value (0.93 g/100 g). The mean ash concentration in the liver was 0.03 g/100 g higher than in the muscle, although this difference was not statistically significant ($p = 0.8923$). However, the liver contained 0.20 g/100 g more ash than the kidney, a significant difference ($p = 0.0338$). Similarly, the muscle had 0.3 g/100 g more ash than the kidney ($p = 0.0130$).

Thus, the ash content across different organs follows the order:

Liver = Muscle > Kidney.

A comparison of ash concentrations between young and adult dromedaries showed no significant difference. According to El-Ghareeb [13], the ash content is an indicator of the mineral richness of meat. Several studies have reported that meat is an excellent source of iron and phosphorus, which are well assimilated by the body, but is relatively low in calcium. These findings are consistent with previous studies. Isam [14] reported that ash concentrations in camel meat range from 0.85 to 1.0 g/100 g, while other studies indicate values between 0.83 and 0.91 g/100 g [2, 15].

## Protein Content

Protein concentrations differed significantly across the analyzed organs. The protein content ranking was as follows:

Liver > Muscle > Kidney (Fig. 1).

The liver exhibited the highest protein concentration (25.68 ± 1.28 g/100 g), followed by the muscle (17.93 ± 2.30 g/100 g), while the kidney had the lowest level (15.88 ± 1.99 g/100 g).

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The mean protein concentration in the liver was 6.64 g/100 g higher than in the muscle, a statistically significant difference ($p < 0.0001$). Similarly, the liver contained 8.63 g/100 g more protein than the kidney ($p < 0.0001$). The muscle had 1.99 g/100 g more protein than the kidney, a significant difference ($p < 0.0001$). No significant difference in protein content was observed between the two age groups studied. Our findings confirm that camel meat is a rich source of protein, consistent with previous studies. Reported protein concentrations in camel meat range from 17.1 to 22.7 g/100 g [14, 15, 16, 17].

**Fat Content**

Fat concentrations varied among the three analyzed organs. The difference in fat content between the liver and kidney was not statistically significant ($p = 0.0748$), while the other two comparisons showed significant differences. The fat content ranking was as follows:

Liver = Kidney < Muscle (Fig. 1).

The muscle exhibited the highest fat concentration (4.26 ± 0.85 g/100 g), followed by the liver (2.93 ± 0.90 g/100 g), while the kidney had the lowest value (1.56 ± 0.90 g/100 g). The mean fat concentration in the liver was 0.99 g/100 g higher than in the kidney, but this difference was not significant ($p = 0.0748$). In contrast, the liver contained 1.75 g/100 g less fat than the muscle, a statistically significant difference ($p = 0.0013$). The muscle had 2.71 g/100 g more fat than the kidney, which was also statistically significant ($p = 0.0001$).

Thus, the fat content across different organs follows the order:

Muscle > Liver = Kidney.

No significant differences in fat concentrations were observed between young and adult dromedaries.

Our findings confirm that camel meat contains a considerable amount of fat, consistent with previous studies. El-Ghareeb [13] reported fat concentrations ranging from 1.9 to 6.2 g/100 g in camel meat. Other studies indicate values between 1.51 and 3.1 g/100 g [2, 15, 17].

**Essential metals**

Concentrations of Iron, Copper and Zinc were compared. Statistical treatment showed that there were significant between the concentration of the metals Iron, Copper and Zinc ($p<0.0001$), between the concentration in the organs ($p<0.0001$), and also that the metals showed significant differences in their concentrations between organs ($p<0.0001$). Iron is most concentrated in kidney (11.54 ± 3.83 mg/100g) while Muscle content the high level of Zinc (6.57 ± 2.42 mg/100g). Copper is more concentrated in liver (7.68 ± 2.16 mg/100g) (Fig.2).No differences were

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detected depending on type of food (P=0.9018) or gender (p=0.3769). The concentration of three metals were significantly different; So, concentration of copper was less than iron (p<0.0001) (Table 5) and then Zinc (p<0.0001), and concentration of Zinc was also less than Iron (p=0.0014).

The concentration of Copper in Liver is 11.04 times greater than in Muscle and 4.49 times greater than in Kidney. Both of these differences were significant (p<0.0001 and p=0.0011 respectively). However, the mean value of the concentration of copper in muscle is only 64% of the value in kidney, this difference being not significant (p=0.5937). So, for Cu: Muscle=Kidney<Liver. The mean concentration of zinc in liver is 3.01 mg/100g lower than in muscle and 4.24 mg/100g greater than in Kidney, being both significantly different. The difference between Liver and Kidney is not significant (p=0.2268). So, for Zn: Muscle>Kidney=Liver (Table 4). The mean concentration of iron in Liver is 4.49 mg/100g greater than in Muscle (p=0.005), and 4.38 mg/100 g lower than in Kidney (p=0.0061). Mean concentration in Muscle is also 8,86 mg/100 g less than in kidney (p<0.0001), being all differences significant. So, for Fe: Muscle<Liver<Kidney.

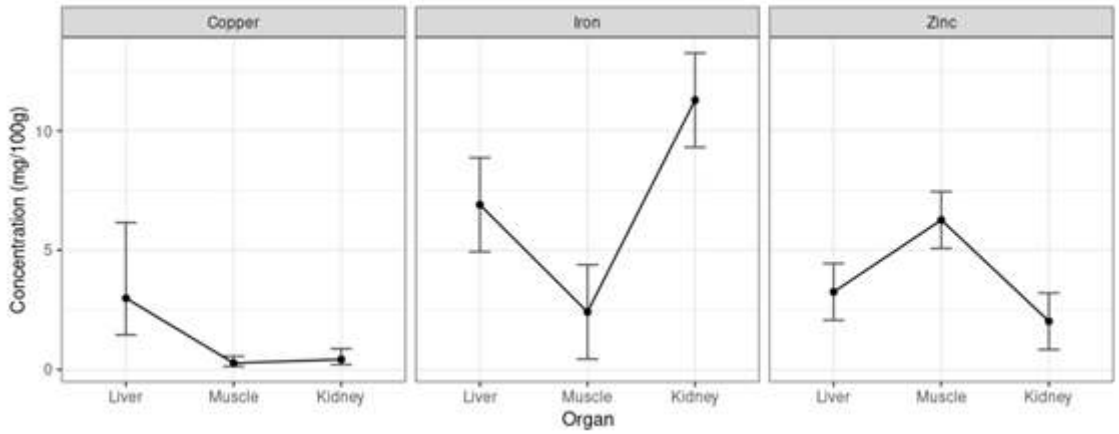


**Figure 2: Main concentration of essential metals by organ**

Table 2 shows the difference between concentrations in both organs for all nutriments.

The study results highlight that camel meat is an excellent source of essential minerals, including iron, zinc, and copper, as supported by previous studies [5, 6, 18, 19]. Camel meat is particularly rich in iron, mainly in its heme form, which is easily absorbed by the body. The concentration typically ranges from 2 to 6 mg per 100 g of meat, making it an effective dietary option for preventing iron deficiency anemia. Zinc, an important trace element for immunity and growth, is present in moderate amounts in camel meat, ranging from 2 to 4 mg per 100 g, similar to some red meats. Copper, which plays a crucial role in red blood cell formation and iron metabolism, is also found in camel meat, with a concentration typically ranging from

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0.1 to 0.3 mg per 100 g, making it a valuable source of this mineral [18, 19]. These values may vary based on factors such as the age of the animal, its diet, and the specific cut of meat analyzed. When compared to other red meats, camel meat generally contains higher levels of iron and moderate amounts of zinc and copper. It is particularly valued in arid regions for its exceptional nutritional benefits.

## CONCLUSION AND RECOMMENDATIONS FOR DEVELOPMENT

This study is the first conducted in Mauritania to investigate the nutritional quality of camel meat by analyzing its total protein, lipid, ash, moisture, and essential trace element (Fe, Cu, Zn) content. The average concentrations of protein, fat, and ash in camel meat were 19.22 g/100 g, 2.78 g/100 g, and 1.07 g/100 g, respectively. Liver had the highest protein content, while muscle contained the highest fat concentration. The concentrations of iron, zinc, and copper were 11.54 mg/100 g, 6.57 mg/100 g, and 7.68 mg/100 g, respectively. Kidney had the highest iron content, whereas copper was most concentrated in the liver. These findings confirm that camel meat has a high nutritional value. Based on the results, a diet including both liver and kidney could be considered nutritionally complete due to their complementary micronutrient content. The results are similar to the same study conducted in other countries in the region and around the world

### Conflict of interest

Authors confirm that there is no conflict of interest

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**Table 1: Nutrients concentrations in camel meat (mean±SD)**

| organ | Age | Moisture | Protein | Fat | Ash | Iron | Zinc | Copper |
|---|---|---|---|---|---|---|---|---|
| Kidney | 3 years | 80.57 ± 1.54 | 15.88 ± 1.99 | 1.53 ± 1.50 | 0.93 ± 0.19 | 11.54 ± 3.83 | 2.24 ± 1.28 | 0.89 ± 1.36 |
| | > 5 years | 81.51 ± 2.04 | 15.11 ± 1.63 | 1.56 ± 0.90 | 0.90 ± 0.15 | 10.67 ± 3.44 | 1.51 ± 0.15 | 0.29 ± 0.13 |
| Liver | 3 years | 70.85 ± 1.75 | 23.69 ± 0.71 | 2.31 ± 0.47 | 1.09 ± 0.23 | 7.50 ± 3.34 | 3.00 ± 1.25 | 3.37 ± 2.92 |
| | > 5 years | 68.36 ± 2.20 | 25.68 ± 1.28 | 2.93 ± 0.90 | 1.19 ± 0.15 | 5.49 ± 2.00 | 3.83 ± 1.60 | 7.68 ± 2.16 |
| Muscle | 3 years | 74.39 ± 2.61 | 17.93 ± 2.30 | 4.24 ± 1.25 | 1.16 ± 0.09 | 2.86 ± 0.62 | 6.57 ± 2.42 | 0.29 ± 0.32 |
| | > 5 years | 74.10 ± 5.63 | 16.98 ± 3.23 | 4.26 ± 0.85 | 1.13 ± 0.12 | 1.37 ± 0.77 | 5.55 ± 2.22 | 0.64 ± 0.43 |

Iron, Zinc and copper in mg/100g; Protein, ash, fat and moisture contents in g/100g

**Table 2:Comparison of concentration of nutrients between organs (first one is the referent)**

| Nutrient | Liver - Muscle | Liver – Kidney | Muscle - Kidney |
|---|---|---|---|
| Copper | 11.04 [3.48, 35.03] (P=0.0001) | 7.06 [2.23, 22.41] (P=0.0011) | 0.64 [0.20, 2.03] (P=0.5937) |
| Iron | 4.49 [1.34, 7.63] (P=0.0050) | -4.38 [-7.52, -1.24] (P=0.0061) | -8.86 [-12.01, -5.72] (P<.0001) |
| Zinc | -3.01 [-4.84, -1.17] (P=0.0015) | 1.23 [-0.60, 3.06] (P=0.2268) | 4.24 [2.41, 6.07] (P<.0001) |
| Ash | -0.03 [-0.22, 0.15] (P=0.8923) | 0.20 [0.01, 0.39] (P=0.0338) | 0.23 [0.05, 0.42] (P=0.0130) |
| Protein | 6.64 [4.69, 8.59] (P<.0001) | 8.63 [6.68, 10.59] (P<.0001) | 1.99 [0.04, 3.95] (P=0.0450) |
| lipids | -1.75 [-2.79, -0.70] (P=0.0013) | 0.96 [-0.08, 2.01] (P=0.0748) | 2.71 [1.66, 3.75] (P<.0001) |


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