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# Muscular and Edible Organ Meat Chemical Composition, Macro and Micro-Elements Distribution and Subcutaneous Fat Properties of Camel and Beef Cattle Calves.

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THIS study was conducted on 12 slaughtered male calves of 6 Sudanese camels aged 2.0-2.5 years and 6 beef of native breed (Baladi) aged 1.5-2.0 years. Samples of Longissimus dorsi muscle (LD), liver, defatted kidneys, subcutaneous fat and blood were taken to investigate their nutrients composition, fatty acids profile and erythrocyte antioxidants activity. The results showed that camel's muscular meat (LD) was characterized by remarkable lower fat content than beef. Beef meat contained 3% less moisture than that of camel. Fat content of camel liver was lower than beef. Camel kidney had higher ash and lower fat contents than those of beef. The histological examination of LD muscle showed lower fat deposition between muscle bundles and thicker collagen tendons in camel than beef. Macro and micro-elements content of muscular meat were higher in camel than beef. Beef liver had higher Ca and lower Fe than camel, while other elements did not attain significant differences between species. Total saturated and unsaturated fatty acids of deposited fat were nearly similar in both species, however lauric, myristic, palmitic, palmitoleic, linoleic and α-linolenic acids were higher in camel fat than beef. Acid and peroxide values were lower of camel fat than those of beef. Erythrocyte enzymatic antioxidants activity was higher in camels than in beef. It could be concluded, that camel meat and offal are economic and healthy protein source and its hump fat contains valuable unsaturated fatty acids and has resistance against oxidative rancidity in comparison with beef fat.

**Keywords**: Longissimus dorsi muscle, edible offal, metal elements, hump fat.

## Introduction

Now-a-days there is a great developing gab between red meat demands and the annual increasing rate of human population fsweetin Egypt (2.5 million newborns/year). To minimize the consequences of this hard situation, it's an inevitable necessity to apply other untraditional strategies to fulfill the gab of red meat insufficiency. Locally fattening camel calves could be a promising economic solution, particularly under the Egyptian ecosystem and limited greenery lands. Numerous studies stated that camel calf meat (2-3 years old) is comparable in texture to that of beef with light sweet taste, due to the high muscular content of glycogen [1; 2; 3 and 4]. Camel meat is characterized by its high-quality protein, low fat and cholesterol contents and a good source of vitamin B12 and important minerals particularly iron, calcium and phosphorus [5; 4 and 6]. Camel meat also contained relatively higher level of poly unsaturated fatty acids than beef. It was also noted that camel meat contains some bioactive

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compounds (carnosine and anserine) functioning as antioxidants in camel meat [7 and 6]. All organ meat including liver, heart, kidneys, lungs with trachea, rumen, intestines, spleen, testicles, head and feet of beef, camels and sheep are traditionally consumed by Arab and African people. Edible offal (liver and kidneys) of beef is the most favorable organ meat consumed worldwide. Beef liver and kidneys have higher minerals content than muscles [8]. Organ meat is highly nutritious food loaded with significant contents of iron, copper, vit. B12, riboflavin, vit. A and has health benefits more than muscle meat, but they are high in cholesterol and saturated fatty acids [9].

This research work was implemented to compare nutrients and some macro and micro-element contents in Longissimus dorsi muscle, liver and defatted kidney of slaughtered male dromedary camel and beef cattle calves. The study also included, comparison between the two species concerning the fatty acid profile of subcutaneous fat and blood erythrocyte enzymatic antioxidants activity.

## Material and Methods

*Animals and meat samples*

Selected animals and slaughter process were conducted at a governmental slaughter house located in Al-Basatien area south - Cairo governorate. The study was carried out on 12 animals of two different species six of each of healthy male Sudanese dromedary camels and native Balady beef calves chosen by weight and age before being slaughtered. The average weight of camels was 350±53.42 kg aged 2.0-2.5 years and 421±71.10 kg for beef aged 1.5-2.0 years old. Age of experimental animals was done through the visual observation of tooth incisors as number and size. The slaughter procedures were implemented according to instructions of the veterinary authority in the slaughter house. Internal organs were checked against infectious diseases and internal parasites before being taken. Samples of deboned Longissimus dorsi muscle (between $12^{th}$ and $13^{th}$ ribs) and 500g of liver, defatted kidneys and camel hump and beef subcutaneous fat (over the dorsal region) were individually collected of each. Meat and fat samples of each animal were separated in zipped labeled plastic bags and immediately transported to the laboratory. Meat samples were refrigerated at +4 °C for 24h. About 200g of each type of chilled meat were trimmed into small pieces, ground using meat grinder and prepared for chemical analysis. Blood samples were individually collected during bleeding in 10 ml heparinized clean dry glass types fitted with rubber stopers and kept under -20 °C until further preparation for enzymatic antioxidants determination.

*Chemical analysis*

Chemical composition (moisture, ash, fat and protein) of meat (Longissimus dorsi muscle, LD) and organs meat (liver and defatted kidneys) was determined according to the standard methods of AOAC [10]. Moisture content was determined as weight loss of 5gm of ground meat. The fresh samples were spread in thin layer on stainless-steel plates and left for dryness in an air- suction oven at 60 °C for 24h. Cool dried samples were individually weighed and the moisture % was calculated as:

(Fresh weight – dried weight) / fresh weight x100.

For ash determination, one gram of dried meat of each sample was placed in dry known weight crucible. The crucibles were placed in muffle furnace at 100 °Cand the temperature was gradually increased until reache 600 °C for 3h, then all samples were left to cool and weighed. Ash % was calculated as:

Weight of (crucible before ashing – weight of crucible after ashing) / dried meat sample x100

Meat fat was determined by extracting fat of 5gm fresh meat in di-ethyl ether for continuous 6h using Soxhlet apparatus. After complete removal of the solvent, fat extracted samples were left to dry at 60 °C overnight and fat % was calculated as follow:

Fat weight / Sample weight x 100

Protein content was determined by the Kjeldahl method. One gram sample of each fat free dried meat was digested in conc. sulphuric acid and titrated with HCL. Protein % was calculated as:

Nitrogen content % x 6.25

*Histological examination*

Cross section (1cm x 1cm) of Longissimus dorsi muscle from each camel and beef calves was taken for histological study. All tested samples were dehydrated in graded ethanol series, imbedded in paraffin and histological sections (5µm in thickness) were prepared, stained with hematoxylin and eosin and examined under a light microscope equipped with digital camera.

*Macro and Micro minerals determination*

About 200g fresh samples of each of meat (LD), liver and defatted kidney from six slaugh-

tered camels and six beef calves were oven dried at 60 °C for 72 hrs., collected, weighed and finally ground. Exact weight of 0.5g from each sample was digested in a solution of 10ml sulphuric acid + 1.0ml perchloric acid. Digested samples were diluted in a 50ml size conical flask to determine different measured minerals. Magnesium (Mg), iron (Fe), zinc (Zn), manganese (Mn) and copper (Cu) were determined by the Atomic Absorption (model: spectra meter analysis 400) according to the standard method mentioned by Cottenie *et al.* [11]. Other minerals calcium (Ca), potassium (K) and sodium (Na) were determined by the Flame photometer (model: Jen way PFP7) as described by Cottenie *et al.* [11]. Phosphorus (P) was determined by the Spectrophotometer [12].

*Analysis of Fatty Acids Methyl Esters*

The identification of the components of fatty acids methyl esters was done as described by Ludde *et al.* [13] for pooled sample of each camel's hump and beef subcutaneous fat using gas liquid chromatography of a Hewlett Packard Model 6890 chromatography under the following conditions:

Separation was done on an INNO wax (polyethylene glycol) Model No. 19095 N-123, 240°C maximum, capillary column 30.0 m x 530 µm x 1.0 µm, nominal flow 15 ml / min. with average velocity 89 cm / sec. and pressure 8.2 psi. Column temperature was 240°C with temperature programming: Initial temperature 100°C to 240°C maximum with 10°C rising for each minute and then hold at 240°C for ten minutes. Injection temperature 280°C, back inlet, with split ratio 8:1, split flow 120 ml, gas saver 20 ml /min.Carrier gas was nitrogen with flow rate 15 ml / min. Flame ionization detector temperature 280°C. Hydrogen flow rate 30 ml / min. –Air flow rate 300 ml / min.

*Acid and peroxide values*

Camel and beef fat refrigerated at +4 °C for 96h were melted and oil sample of each animal was determined as previously described in AOCS [14].

*Erythrocytes antioxidant enzymes*

Collected blood samples of different slaughtered animals were removed from the deep freezer (-20 °C) and kept under room temperature (30-33 °C) for 24 hrs. till complete defrosting. The whole blood samples were subjected to the following preparation steps:

1-Red blood cells were collected by centrifuging the whole blood samples at 4000 r.p.m. for 15 min. and the resultant yellow plasma layer was pipetted off.

2-The white buffy layer was removed and discarded.

3- The red cells were washed with 10 volumes of cold saline solution.

4-The erythrocytes lysed in four volumes of cold deionized water.

5- The red cell stroma was removed by centrifugation at 4000 r.p.m. for 10 min.

Erythrocyte lysates were kept in ice during time of enzymatic determination and rest of samples were kept at -80 c° until further determinations.

The glutathione (GSH) peroxidase was determined according to Paglia and Valentine [15]. Glutathione reductase (GR) was determined according to Goldberg and Spooner [16]. Superoxide dismutase (SOD) was determined as mentioned by Nishi Kimi *et al.* [17]. Catalase was determined as described by Fossati *et al.* [18].

*Statistical analysis*

Collected data of measurable parameters (except fatty acids profile) were subjected to Two Independent Sample t-Test according to Snedecor and Cochran [19] using the following mathematical model:

$$t_{cal} = \frac{x_1 - x_2}{SP\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

$$SP^2 = \frac{(n_1 - 1)\,S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}$$

SPSS [20] was applied to calculate t- values of different parameters and significant differences between means were measured at d*f* = 10 where P value= 2.228 at P<0.05 and 3.169 at P<0.01.

## Results and Discussion

*Chemical composition*

Chemical composition of Longissimus dorsi muscle, liver and defatted kidney for slaughter camel and beef calves is presented in Table [1]. Moisture content was insignificantly higher by nearly 3% in camel muscle than that of beef (75.21% vs. 71.92%). Similar results had been reached by many researchers who stated that moisture content of camel meat was varying from 63 to 77.7% as it influenced by age, gender, muscle type and feeding system (3; 21; 2 and 6). It was clear that, the fat content in camel muscle was (P<0.01) lower than that in beef (1.81% vs. 5.29% on fresh weight basis).

The protein content was slightly higher in beef muscle (21.26%) than camel (20.12%). Ash

content of muscle meat was comparable in both animal species. The protein of young camel muscle meat was noted to vary from 17.1 to 22.1% which is similar to the protein content to that of cattle calves, sheep and goat meat [4]. The fat content of camel meat was reported to be significantly lower than beef and sheep, however the nutritional value is varying according to breed, feeding regimen, age, season and type of meat cut [22 and 4]. Liver composition showed comparable values of most nutrients except fat content which was (P<0.05) lower in camel than beef. Defatted kidney of camels and beef showed insignificant differences for protein and moisture contents, while its fat content was (P<0.01) lower and ash was (P<0.01) higher in camel than beef (Table1). In comparison with other tissues, ash content recorded the highest value in camel kidney and was nearly two times higher than beef. The ash content in dromedary camel meat was reported to range 0.75 - 1.38% (fresh tissue), where it varies among muscular meat cuts and organs (23 and 4). Ash content was also noted to be increased with age [24], whereas others found no effect of age on ash content [3]. Other studies reported that camel meat had relatively lower ash content than beef [3 and 24]. In agreement with our results, Beil *et al.* [8] reported that *semitendinosus* muscle of calves was lower in ash than liver and kidney. Some other studies gave contradictory results of ash content in different animal tissues that could be attributed to animal species, feeding practices, ecological conditions, drinking water quality. The cross section of LD muscle for camel and beef shown in Photos [1] and [2], indicate that camel tissue had darker red color and coarser appearance than that of beef. The histological examination of the *Longissimus dorsi* of camel and beef given in Figures [1] and [2], illustrates that beef muscle contained much obvious intramuscular fat between muscle bundles than camels, while the collagen tendons seemed much thicker and deeply diffused in the muscle section. This muscular structure of camels might be the reason of camel meat toughness, poor odor and taste, coarse texture and hard chewability. Similar observations were noted by Shareha *et al.* [25], who stated that the large increase in myofibrils and muscle fibers diameter reduces the percentage of fat deposition between muscle fibers in camel meat.

*Minerals content*

Macro and micro elements contents in muscle meat, liver and kidney of camels and beef calves are given in Table [2]. The results of macro elements content of LD muscle showed higher phosphorus (P<0.01) and sodium (P<0.05) for camel than beef, while the difference between species did not attain significancy for Ca, K and Mg. Corresponding elements in liver recorded insignificant differences between species except Ca which was (P<0.01) higher in beef than camel. Camel kidney contained two times higher Ca and Na than those of beef, while other elements were nearly similar in camel and beef. Data of micro elements showed obviously higher Fe content in all tested tissues of camels than beef. Zinc concentration was not statistically different between species in LD muscle and liver, while it was (P<0.01) higher in camel kidney than that in beef. There was no species effect on Mn concentration in different tested tissues. Copper concentration was two times higher (P<0.01) in camel LD muscle and kidney tissues in comparison with that of beef. With exception of the discrepancy among studies concerned with minerals concentrations in meat of different species, the present results were in line with the findings reported by Kadim *et al.*, [6] on camel meat, which showed that camel meat is comparable to other red meat of beef and mutton. Potassium was noted to be the most predominant macro-element followed by P then Na in red meat of both cattle and camel. Calcium was noted to be slightly higher in camel meat than cattle [3], but our results pronounced higher Ca in cattle liver than that of camel, meanwhile Ca was much higher in camel kidney than that of beef. In accordance with our results, Mahmud *et al.* [5] reported that camel meat contains significantly higher level of K, Fe, P and Na as compared to beef similar conclusion was stated by Abdelbasset *et al.* [26]. Studies on organ meat minerals contents of camel were scarcely available, but viewer studies were carried out on cattle and sheep. In this concern, Beil *et al.* [8] compared macro and micro-elements in offal of beef veal and sheep. They found that Ca, P, K, Fe, Zn, Cu, Na and Mn (mg/ 100g fresh tissue) were respectively, 5, 387, 310, 4.8, 4, 9.66, 68 and 0.26 in liver and 13, 255, 272, 4.6, 1.95, 0.43, 185 and 0.07 in kidney. Our results on beef seemed compatible with previous results when calculated on dry tissue. In general, camel muscular and organ meats are rich source of Fe and Zn where these two elements are important for human nutrition due to their physiological function, where iron is the key mineral for oxygen transport, energy production and synthesis of enzymes. Zinc also has catalytic function for many zinc-dependent enzymes beside its effect on cell membrane maintenance and fat oxidation prevention.

**TABLE 1. Chemical composition on wet tissue of Longissimus dorsi (LD) muscle, liver and defatted kidney of camels and beef calves. (means ± Sd).**

| Species | Moisture | Protein | Fat | Ash |
|---|---|---|---|---|
| Longissimus dorsi muscle | | | | |
| Camel | 75.21±1.24 | 20.12±0.73 | 1.81±0.06 | 1.44±0.03 |
| Beef | 71.92±1.32 | 21.26±1.51 | 5.29±0.22 | 1.26±0.11 |
| Significancy | NS | NS | ** | NS |
| Liver | | | | |
| Camel | 71.90±1.76 | 22.67±0.81 | 3.20±0.62 | 1.23±0.05 |
| Beef | 72.25±1.54 | 20.35±0.72 | 4.46±0.94 | 1.31±0.11 |
| Significancy | NS | NS | * | NS |
| Defatted kidney | | | | |
| Camel | 76.92±1.17 | 18.29±1.08 | 2.95±0.26 | 1.62±0.15 |
| Beef | 76.25±2.39 | 17.28±0.79 | 4.68±0.96 | 0 .85±0.03 |
| Significancy | NS | NS | ** | ** |

NS=non-significant *= Significant at P<0.05 **= Significant at P<0.01

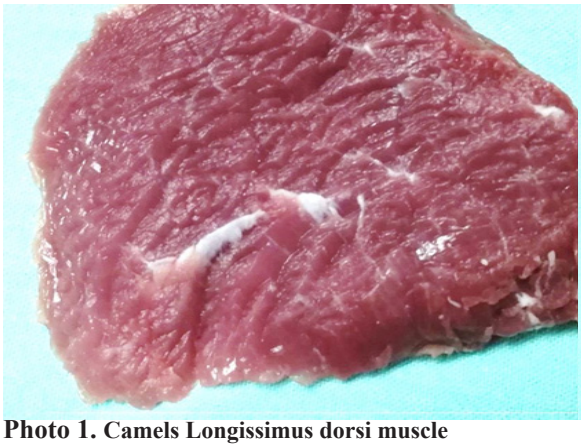

**Photo 1. Camels Longissimus dorsi muscle**

**Photo 2. Beef Longissimus dorsi muscle**

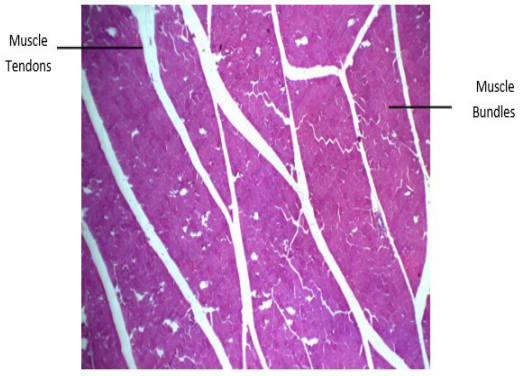


**Fig. 1. Cross section in Camels Longissimus dorsi (40 X)**

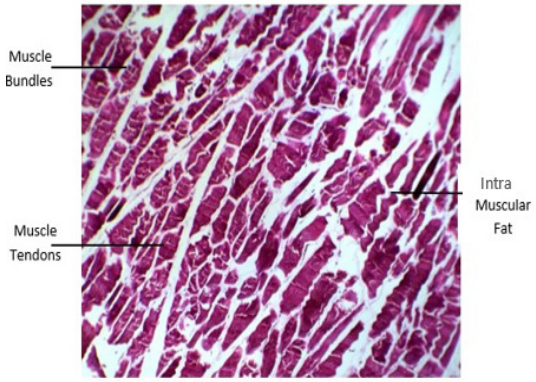


**Fig. 2. Cross section in beef Longissimus dorsi (40 X)**

**TABLE 2. Macro and micro-elements distribution in Longissimus dorsi (LD) muscle, liver and defatted kidney of camels and beef calves. (means ± Sd).**

| | Macro-elements g/100g | | | | | Micro-elements mg/100g | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Animal species** | **Ca** | **P** | **K** | **Mg** | **Na** | **Fe** | **Zn** | **Mn** | **Cu** |
| **Longissimus dorsi** | | | | | | | | | |
| Camel | 0.05 ±0.01 | 1.00 ±0.08 | 1.81 ±0.21 | 0.10 ±0.02 | 0.69 ±0.11 | 435.2±23.1 | 82.0 ±4.2 | 5.8 ±0.3 | 4.4 ±0.9 |
| Beef | 0.07 ±0.03 | 0.69 ±0.05 | 1.56 ±0.12 | 0.08 ±0.01 | 0.41 ±0.06 | 351.0±37.0 | 81.6 ±7.1 | 5.5 ±0.6 | 2.4 ±0.5 |
| Sig. | NS | ** | NS | NS | * | ** | NS | NS | ** |
| **Liver** | | | | | | | | | |
| Camel | 0.05 ±0.02 | 1.38 ±0.17 | 0.94 ±0.08 | 0.07 ±0.01 | 0.35 ±0.02 | 655.0±39.4 | 67.8 ±5.17 | 24.1 ±5.0 | 0.83±0.3 |
| Beef | 0.09 ±0.02 | 1.34 ±0.26 | 1.19 ±0.38 | 0.06 ±0.02 | 0.34 ±0.05 | 458.2±31.26 | 57.9 ±4.29 | 19.3 ±2.7 | 0.78±0.2 |
| Sig. | ** | NS | NS | NS | NS | ** | NS | NS | NS |
| **Kidney** | | | | | | | | | |
| Camel | 0.14 ±0.07 | 1.03 ±0.13 | 1.30 ±0.10 | 0.08 ±0.01 | 1.57 ±0.43 | 707.3±42.2 | 88.4 ±5.0 | 6.4 ±0.2 | 30.8±4.1 |
| Beef | 0.06 ±0.11 | 1.12 ±0.05 | 1.25 ±0.04 | 0.09 ±0.03 | 0.81 ±0.25 | 472.0±33.6 | 48.1±6.4 | 6.6 ± 0.4 | 15.8±1.6 |
| Sig. | ** | NS | NS | NS | ** | ** | ** | NS | ** |

Mineral: Calcium(Ca), Phosphorus(P), Potassium(K), Magnesium(Mg), Sodium(Na), Iron(Fe), Zinc(Zn), Manganese(Mn), Copper(Cu)
Ns=non-significant *= significant at P<0.05 **= Significant at P<0.01.

*Fatty acids profile, acid and peroxide values*

Results of fatty acids profile of camel hump fat and beef subcutaneous fat presented in Table (3) illustrate that, camel fat had slightly lower total saturated (SFA) and unsaturated fatty acids (USFA) than those of beef. Camel fat in comparison with that of beef showed higher contents of Lauric (C12:0), Myristic (C14:0), Palmitic (C16:0), Palmitoleic (C16:1), Linoleic (C18:2) and α-Linolenic (C18:3) acids. while beef fat had higher contents of stearic and oleic acids than camel. In our study, the most predominant fatty acids in camel fat were palmitic (C 16:0) 31.88% and stearic (C 18:0) 30.01%, whereas stearic and oleic (C 18:1) acids had the highest contents being respectively, 44.17 and 26.16% in beef fat. Total SFA and USFA were nearly comparable in fat of both species where they recorded respectively 67.36 and 26.23% in camel and 68.69 and 29.38% in beef. An opposite trend was noticed by Jassim *et al.* [27] who reported that hump fat had higher SFA% than beef tallow (66 vs. 56) but lower USFA% (32.6 vs.43.5).

In agreement with the present results, Jassim *et al.* [27] noted that the main fatty acids of camel hump fat were palmitic (33.8%), stearic acid (25.9%), oleic (18.1%). In this respect Kadim *et al.* [6] reported that the average 45% of total fatty acids is SFA in the camel muscle and approximately 1/2 of SFA is palmitic and 1/3 is stearic acid. They added that, fatty acids composition of intramuscular is changeable from one muscle to another. They also tabulated values ranging 48.6-51.8% for total SFA, 48.2-51.4% for total USFA in camel muscles fat versus 54.1% for TSFA and 40.5% for total USFA in beef cattle. Not only fatty acids in adipose tissues are influenced by animal species or place of fat storage but also with animal age. Kadim *et al.* [4] noted that the highest USFA% and lowest SFA% were found in camels of less than one year, whereas the opposite trend was found in animals aged 1-3 years old. Photos (3 and 4) show slices of camel hump fat and beef subcutaneous fat. Camel fat was firm and of a white color but after slicing the color changed into a light pink, while beef fat had a constant yellowish color. The change of hump fat color and firmness could be regarded to the blubber layer surrounded hump adipose tissue which contains many blood vessels than fat and it's made up of a mixture of collagen and lipids. It's interesting to note that the total Linoleic and Linolenic acids (PUSFA) in this study constituted 4.42% of the total hump fatty acids compared to 2.23% for beef fat.

**TABLE 3. Fatty acids profile expressed as % of total fat of camel and beef calves subcutaneous fat.**

| Item | Camel fat | Beef fat |
|---|---|---|
| Lauric acid (C 12:0) | 0.31 | 0.00 |
| Myristic acid (C 14:0) | 5.16 | 2.82 |
| Palmitic acid (C 16:0) | 31.88 | 21.7 |
| Palmitoleic (16 :1) | 2.25 | 0.99 |
| Stearic (C 18 :0) | 30.01 | 44.17 |
| Oleic (C 18:1) | 19.56 | 26.16 |
| Linoleic acid (C 18:2) | 3.63 | 2.23 |
| **α**-Linolenic acid (C 18:3) | 0.79 | 0.00 |
| Total saturated fatty acids | 67.36 | 68.69 |
| Total unsaturated fatty acids | 26.23 | 29.38 |

**Photo 3. Camels hump fat**

**Photo 4. Beef subcutaneous fat**

These acids are very important bioactive components where it acting as anti-oxidants, anti-catabolize, powerful immune enhancer, help in burn fat and enhance muscle growth beside their effect in reducing harmful cholesterol (LDL) and heart failure. Kadim *et al.* [6] supported our findings that PUSFA were much higher in camel muscles fat than that of beef. They tabulated values of Total PUSFA ranging 11.4-16.6% for camel muscular fat vs. 5.44% for beef. However, Jassim *et al.* [27] found opposite result that total linoleic and linolenic were 2.11% in hump fat and 3.0% in beef tallow. The contradictory results could be attributed to animal different age, gender, ecological conditions, feeding practices, fat tissue type and place in the carcass.

Acid and peroxide values measured after 96 hr. of refrigeration at 4°C for camel and beef fat are given in Table (4). The results indicate that camel fat had much lower ($P<0.01$) values than those of beef. Such results are pointing to that camel fat has potential resistance to oxidative rancidity. Meanwhile, Gheisari [24] in his comparative study on stored meat of cattle and camel, reported higher acid and peroxide values for camel than cattle meat being respectively, 2.45 vs. 2.25 $mEqO_2$ and 0.35 vs.0.25 µmol/kg after 4 days storage at 4°C. It's well known that; the high acid value is based on amount of free fatty acids indicate hydrolysis rancidity or fat and oil deterioration .The high peroxide level indicate that oil has been damaged by free radicals which give rise to aldehydes and ketones formation resulted in musty smell and rancid taste. In accordance with the present results, Mashaly *et al.* [28] noted that camel hump fat had high oxidation stability than renal or mesentery fat.

Available comparative studies between animal species concerning their adipose tissue physico-chemical properties were scarcely available for particularly camel and other studies on cattle were carried out on trimmed fat (renal and mesentery

fat) to be processed as beef tallow which is different in composition than the subcutaneous or hump fat.

*Antioxidant enzymes*

Erythrocytes antioxidant enzymes of glutathione peroxidase, glutathione reductase, superoxide dismutase and catalase were remarkably higher (P<0.01) in camel than beef (Table 5). Endogenous enzymatic antioxidants are playing a significant role in protecting body tissues from the dangerous oxidative products (ROS) that are generating in animals exposed to environmental stresses. They have also a significant role in protecting meat fat from oxidation during meat processing or storage [24]. The biological action of enzymatic antioxidants is to convert oxidative products to hydrogen peroxide ($H_2O_2$) then to water in presence of some minerals as co-factors such as Cu, Fe, Zn, Mn, Se. Cells are able to protect themselves against ROS damage via intracellular enzymatic reactions, metal chelating and free radical scavenging action to keep balance between radical generation and radical scavenging. The present results are supporting the previous opinion that camels have exceptional tolerance against environmental stresses i.e., heat, feed insufficiency, thirsty, long walking distance and high immunity against infectious diseases (1; 3, 4 and 6). So, it seems logic to expect higher enzymatic antioxidants activity in camels than beef, where camels are exposed to unfavorable environmental and climatic conditions during their travel to Egypt for direct slaughter.

**TABLE 4. Acid and peroxide values of subcutaneous fat of camels and beef calves.**

| Item | Camel fat | Beef fat | Significancy |
|---|---|---|---|
| Acid value (mg KOH / g oil) | 0.95±0.01 | 3.19±0.32 | ** |
| Peroxide value (meq $O_2$ / kg oil) | 0.88±0.02 | 2.35±0.12 | ** |

**= Significant at P<0.01

**TABLE 5. Erythrocytes antioxidant enzymes of slaughtered camels and beef calves.**

| Item | GSH (µl/ml) | GR (IU/ml) | SOD (U/ml) | Catalase (U/dl) |
|---|---|---|---|---|
| Camel | 3.81±0.05 | 8.32±0.11 | 330±3.32 | 253±2.78 |
| Beef | 3.51±0.12 | 6.02±0.63 | 287±9.35 | 223±10.51 |
| Significancy | ** | ** | ** | ** |

GSH= glutathione peroxidase GR= glutathione reductase SOD= superoxide dismutase, **= Significant at P<0.01

## Conclusion

The results of this study are shedding more light on the health aspects of camel muscle meat that characterized by low fat and cholesterol contents beside its offal (liver and kidneys) are loaded with effective macro and micro-elements particularly iron, however organ meat consumers should give attention to the high Na ions in camel kidney. The hump fat contains valuable poly unsaturated fatty acids and has exceptional resistance against oxidative rancidity in comparison with that of beef. The high erythrocyte enzymatic antioxidants as well might help camels to resist epidemic diseases. For more confident results, similar futuristic studies should be carried out on a larger number of animals and under different environmental and feeding conditions to support the pivotal role of camel as cheap and healthy meat provider in developing countries.

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*Conflicts of Interest*

The authors declare that there were no conflicts of interest concerning all steps of this study.

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## التركيب الكيميائى وتوزيع العناصر المعدنية الكبرى والصغرى فى لحم العضلات والاحشاء الماكولة وخصائص الدهن المخزن تحت الجلد للعجول البقرى والابل.

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أجريت هذه الدراسة على 12 عجل مذبوحاً ، ٦ من الابل السودانية عمر 2.5-2 سنة و 6 من الأبقار المحلية (بلدي) عمر 2.0-1.5 سنة. تم أخذ عينات من العضلة العينية والكبد والكلى منزوعة الدهن والدهون تحت الجلد والدم ، للتحقق من تركيبهم الكيميائي وشكل الأحماض الدهنية ونشاط مضادات الأكسدة في كريات الدم الحمراء. وأظهرت النتائج أن لحم الإبل العضلي (LD) يتميز بمحتوى دهني أقل بشكل ملحوظ من لحم البقر. يحتوي لحم البقر على رطوبة أقل بنسبة ٣٪ من لحم الجمل. وكان محتوى الدهون في كبد الإبل أقل من لحم البقر. تحتوي كلية الجمل على نسبة رماد أعلى ومحتوى دهون أقل من تلك الموجودة في لحم البقر. أظهر الفحص النسيجي لعضلات LD انخفاض ترسب الدهون بين حزم العضلات وأوتار الكولاجين الأكثر سمكًا في الإبل مقارنة بلحم البقر. كان المحتوى الكلي والعناصر الدقيقة في اللحوم العضلية أعلى في لحم الإبل منه في لحم البقر. كان كبد البقر أعلى من الكالسيوم وأقل من الحديد مقارنة بالإبل، في حين لم تظهر العناصر الأخرى اختلافات معنوية بين الأنواع. كان إجمالي الأحماض الدهنية المشبعة وغير المشبعة للدهون المترسبة متشابهًا تقريبًا في كلا النوعين، إلا أن أحماض اللوريك، الميريستيك، البالمتيك، البالميتوليك، الليناوليك، ألفا لينولينيك كانت أعلى في دهون الإبل مقارنة بلحم البقر. وكانت قيم الحموضة والبيروكسيد أقل في دهن الإبل من تلك الموجودة في لحم البقر. كان نشاط مضادات الأكسدة الأنزيمية في كريات الدم الحمراء أعلى في الإبل منه في لحم البقر. ويمكن الاستنتاج أن لحوم الإبل ومخلفاتها هي مصدر بروتيني اقتصادي وصحي، كما أن دهن سنامها يحتوي على أحماض دهنية قيمة غير مشبعة ولها مقاومة ضد الحالة التأكسدية مقارنة بدهون لحم البقر.

**الكلمات الدالة:** العضلة العينية، المخلفات الصالحة للأكل، العناصر المعدنية، دهن السنام.