Quality of young one- humped Egyptian camel meat obtained from different anatomical locations

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ABSTRACT

This study characterized the chemical composition and quality *of Triceps brachii* (from forequarter and *Semitendinosus* muscles from hindquarter of fifteen one humped camel carcasses obtained from animals slaughtered at about 5 years old. There were non-significant ($p<0.05$) differences in moisture, protein and ash contents between the two investigated muscle samples. The *Triceps brachii* muscle had significantly ($p<0.05$) higher fat content than that of the *Semitendinosus* muscle. Moreover, there were non-significant ($p<0.05$) differences in pH and TBARS values among investigated muscle samples. Furthermore, there were non-significant ($p<0.05$) differences in total soluble, sarcoplasmic and myofibrillar proteins between two muscles. On the other hand, the myoglobin content of *Semitendinosus* muscle were significantly ($P<0.05$) higher than that of *Triceps brachii* muscle. *The Triceps brachii* muscle had higher collagen content (0.9%) and shear force (10 kg/f) value than those of *Semitendinosus* muscle. The higher L* value was noted in *Semitendinosus* muscle than *Triceps brachii*. However, a* and b* values were not significant ($p<0.05$) differ among the two muscles. This study indicated that composition and quality parameters were varied among camel muscles of fore and hindquarter and the knowledge of this variation allows for better marketing and processing of camel meat.

(Key words: camel meat, meat quality, proteins, collagen, shear force, color)

INTRODUCTION

Camel is unique animal for having an ability to survive under adverse climatic conditions such as high ambient temperatures, low rainfall and scarcity of feed. Therefore, the camel is a good source of meat in hot arid areas where the bad climate adversely affects production efficiency of other animals rather than camel.

Chemical composition is an important indicator of meat functionality and quality. Camel meat varies in composition according to breed, age, sex, condition and muscle location. Chemically camel meat contain more moisture and protein than beef meat **(Al-Owaimer, 2000; Kadim and Mahgoub, 2006)**. On the other hand, camel meat had a significantly lower level of sarcoplasmic proteins **(Babiker and Tibin, 1986)** and intramuscular fat content **(Kadim and mahgoub, 2008)** than beef.

The demand of camel meat is greatly increased because of its low fat content and relatively high polyunsaturated fatty acid content **(Kadim and mahgoub, 2008)** which is considered an important factor in reducing the risk of cardiovascular disease **(Giese, 1992)**. However, camel meat is considered a healthy food, it is classified as a low quality meat compared to beef **(Kadim and Mahgoub, 2006)**. Slaughtering age of camels is the key factor determines the quality of their meat. Camels are usually slaughtered at the end of their productive life (>10 years). Subsequently, consumers sense that camel meat is unacceptably tough **(Kurtu, 2004)**. However, the quality of meat produced by younger camels (5 years or less) was comparable to beef in taste and texture **(Babiker and Yousif, 1990)**. Most of previous studies were concentrating on the quality of camel meat slaughtered at advanced age; however, evaluation of meat obtained from younger camel is scarce. So, the aim of the present study, was to evaluate the chemical analysis, determination of deterioration criteria, measurement of shear force and color evaluation of two major camel muscles *(Triceps brachii and Semitendinosus)* obtained from young animals (about 5 years old).

MATERIALS AND METHODS

1. Samples collection :

Muscle samples were collected from fifteen camel carcasses (one humped) slaughtered at about 5 years old. Each sample include 2 major muscles, *Triceps brachii* from forequarter and *Semitendinosus* muscle from hindquarter were obtained during the period from January 2106 to August, 2016 from a local butcher shop in Kerdasah, Giza, Egypt where animals were slaughtered and dressed following routine traditional halal procedure. Muscle samples were obtained 1 hour after slaughter. Samples were transported in an insulated cool box as rapidly as possible from the slaughterhouse to the laboratories of the Faculty of Veterinary Medicine, Cairo University and kept in a chiller (4°C) for 18 hours (overnight) before investigations were performed.

2. Chemical analysis

2.1. Proximate analysis

Each meat sample was rendered into uniform mass by passing three times through a meat mincer (Fama, Fabbrica Attrezzature Macchine Alimentrac, Rimini-Italy) and mixed thoroughly after each mincing time before being used for determination of moisture, total protein, ether extractable lipids and ash as recommended by **(AOAC, 2000**).

2.2. Determination of deterioration crieteria

2.2.1. Measurement of pH value

Five grams from each of the prepared muscle sample were homogenized with 20 ml distilled water for 10-15 seconds **(Kandeepan et al., 2009).** The pH value was measured using pH meter (Lovibond Senso Direct) with a probe type electrode (Senso Direct Type 330) where three reading for each sample were obtained and the average was calculated. The pH meter was calibrated every two samples using two buffers 4.0 and 7.0.

2.2.2. Thiobarbituric Acid Reactive Substances "TBARS"

Five grams from each muscle sample were homogenized with 15 ml deionized distilled water using a stomacher (Lab blender 400) for 10 seconds at the highest speed. One milliliter of the homogenate was mixed with 50 µl butylated hydroxyanisole (7.2%) and one ml each of 15mM 2-thiobarbituric acid and 15% trichloroacetic acid. The mixture was vortexed, incubated in a boiling water bath for 15 minutes to develop color, then cooled under running water for 10 minutes, vortexed again, and centrifuged for 15 min at 2500 rpm. The absorbance of the resulting supernatant was measured at 531 nm using Unico 1200 (USA) series spectrophotometer against a blank containing 1 ml of deionized water and 2 ml of 2-thiobarbituric acid-trichloroacetic acid solution. The reading was multiplied by 7.8 to obtain the value of thiobarbituric acid reactive substances expressed as milligrams of malonaldehyde per kilogram of the sample **(Du and Ahn, 2002).**

2.3. Measurement of soluble proteins

2.3.1. Sarcoplasmic proteins

Sarcoplasmic proteins solubility was determined by homogenizing 1 gram of raw muscle sample in 10 ml of ice-cold 25 mmol/l potassium phosphate buffer (pH 7.2) using a stomacher (Lab blender 400) at the lowest speed. Homogenate was left to stand in a shaking water bath (GFL-1083, Germany) at 4±°1C overnight. The mixture was then centrifuged at 1500g for 20 minutes **(Joo et al., 1999),** and the protein concentration of the supernatant was determined using Kjeldahl method **(Tyszkiewicz and Klossowska, 1997).**

2.3.2. Total soluble and myofibrillar proteins

Total soluble proteins were determined by homogenizing 1 gram meat sample in 20 ml ice-cold 1.1 mol/l potassium iodide in a 100 mol/L phosphate buffer (pH 7.2). The procedures for homogenization, shaking, centrifugation, protein determination were the same described for sarcoplasmic protein. Myofibrillar proteins were obtained by calculating the difference between total and sarcoplasmic protein. **(Joo et al., 1999**

2.3.3. Determination of Myoglobin Content

The pH value of meat samples were determined using the AOAC method (1980). The samples were homogenized for 2 minutes in cold water and mixed with X ml 1N H_2SO_4 in a waring blender, where X ={ (pH sample -5) x 0.35}. The homogenate was centrifuge (MLW T5, GRD) at 3000 rpm for 2 minutes in a polyethylene tube (50ml. The supernatant obtained was transferred to a 50ml tube and heated slowly to reach a temperature of 54°C after which it was soaked in a water bath to reach 25°C. The homogenate was placed in a100ml beaker and the pH brought to 7.2 using Na_2 Co_3 . The homogenate was transferred back to 50 ml tube and centrifuged for 10 minutes at 2500 rpm. The supernatant was filtered into a 50ml Erlenmeyer flask and 2-3 small crystals of potassium ferricyanide added. Absorbance was read at 540 nm using Unico 1200 (USA) series spectrophotometer **(Topel, 1949).**
Myoglobin content (%) = absorbance x 7.50

2.4. Determination of collagen content

Soluble and insoluble collagen content of meat samples were determined according to the procedure of **Nueman and Logan (1950)** and **Mahendrakar et al. (1988)**. Two grams of meat sample were cooked in water bath and hydrolyzed with 40 ml of 6 N HCl in a hot air oven (Heraeus D-63450 Hanau, Germany) at 105ºC for 18 hours. The hydrolysate was filtered, and the volume was adjusted to 50 ml with distilled water. pH value of 25 ml aliquot was adjusted to 7.0 with 40% NaOH and the volume was made to 50 ml with distilled water. One ml from the obtained aliquot was mixed with 1 ml each of 0.001 M copper sulfate, 2.5 N NaOH and 6% H_2O_2 (For blank,1 ml distilled water was used instead of the aliquot).

After mixing, the tubes were kept at room temperature for 5 minutes with occasional shaking. The tubes were then heated at 80ºC for 5 minutes in a water bath (Kubota YCW-04M, Japan) with frequent rigorous shaking, then cooled in ice, and 4ml of 3N H_2SO_4 and 2 ml of 5% 4-dimethylaminobenzaldehyde in n-propanol were added. After thorough mixing, the tubes were heated again at 70ºC for 16 minutes in water bath. Absorbance of the test sample was measured at 540 nm against the blank using Unico (1200 Series, USA) spectrophotometer. The calculation for estimating the hydroxyproline (g/100 g) in meat was outlined by **Woessner (1961)** using the following equation

$$\text{Hydroxyproline (g/100g)} = \frac{O_U \times C_S \times T_A \times T}{O_S \times A \times V \times W \times 1000 \times 1000} \times 100$$

Where

O_U	Optic density of the unknown	C_s	Concentration of the standard
T_A	Total volume from which aliquot was taken	T	Total volume made
O_S	Optic density of the standard	A	Aliquot taken
V	Volume of solution used for neutralization	W	Weight of the sample taken

Collagen content =Hydroxyproline solubilize% × 7.25

2.5. Determination of collagen solubility

Five grams of raw meat samples were heated to boiling temperature and held for 30 minutes. The cooked meat was then cut into small pieces and homogenized with 50 ml distilled water at 4±1ºC in a blender for 2 minutes. The extract was then centrifuged (MLW T5, GRD) at 1500g for 30 minutes. Aliquots of cooked out juice and centrifugate were hydrolyzed for 18 hours and soluble hydroxyproline was calculated **(Mahendrakar et al., 1989)** as in collagen content.

Collagen solubility (g%) = Solubilize hydroxyproline X 7.14

$$\text{Collagen solubility \%} = \frac{\text{Soluble Collagen}}{\text{Collagen content}} \times 100$$

2.6. Measurement of Shear Force

From each meat sample, four samples (1x 1x1 cm) were cut and the shear force was estimated by Instron Universal Testing Machine (Model 2519-105, USA) with the shear force machine was adjusted at crosshead speed of 200 mm/min **(Shackelford et al., 2004)**.

2.7. Color evaluation

Meat color was measured using Croma meter (Konica Minolta, model CR 410, Japan) calibrated with a white plate and light trap supplied by the manufacturer. Color was expressed using the CIE L*, a*, and b* color system. The average score of triplicate experiments was recorded, and expressed as Commission International de l'Eclairage (CIE) lightness (L*), redness (a*), and yellowness (b*) **(Shin et al., 2008)**.

2.8. Statistical analysis

Each analysis was run in three replicates and collected data were analyzed using SPSS statistics 17.0 for windows. Results were recorded as mean ± SE. Analysis of variance was performed by ANOVA procedure to compare between chemical attributes of *camel Triceps brachii* and *Semitendinosus* muscles by the least significant difference (LSD) and significance was defined at $P<0.05$.

RESULTS

Table (1): Proximate chemical analysis (%), pH and TBARS values of camel muscles

Muscle	Moisture	Protein	Fat	Ash	pH	TBARS
Triceps brachii	$77.36^{a}\pm0.29$	$20.41^{a}\pm0.24$	$1.86^{a}\pm0.14$	$0.97^{a}\pm0.11$	$5.70^{a}\pm0.03$	$0.19^{a}\pm0.04$
Semitendinosus	$77.62^{a}\pm0.10$	$20.87^{a}\pm0.22$	$1.33^{b}\pm0.14$	$1.03^{a}\pm0.08$	$5.50^{a}\pm0.02$	$0.24^{a}\pm0.04$

* a-b: Means with different superscripts differ significantly at $p<0.05$.

Table (2): Protein fractionation (%) of camel muscles

Muscle	TSP	SP	MP	MY	CC	CS
Triceps brachii	$7.08^{a}\pm0.27$	$4.23^{a}\pm0.25$	$2.87^{a}\pm0.46$	$4.06^{a}\pm0.35$	$0.90^{a}\pm0.12$	$0.11^{a}\pm0.01$
Semitendinosus	$7.35^{a}\pm0.21$	$4.05^{a}\pm0.11$	$3.30^{a}\pm0.40$	$5.23^{b}\pm0.32$	$0.40^{b}\pm0.02$	$0.04^{b}\pm0.004$

* a-b: Means with different superscripts differ significantly at $p<0.05$.

TSP= Total soluble proteins, SP=Sarcoplasmic proteins, MP= Myofibrillar proteins, MY= myoglobin content, CC= Collagen content, CS= collagen solubility

Table (3): Shear force (Kg/f) and color values of camel muscles

Muscle	Shear force	Color		
		L*	a*	b*
Triceps brachii	$10.0^{a}\pm0.34$	$34.71^{a}\pm0.82$	$18.89^{a}\pm0.20$	$4.03^{a}\pm0.31$
Semitendinosus	$8.88^{b}\pm0.26$	$38.00^{b}\pm0.5$	$18.81^{a}\pm0.26$	$4.53^{a}\pm0.20$

* a-b: Means with different superscripts differ significantly at $p<0.05$.

DISCUSSION

Meat quality is regarded as the composition of desired and undesired characteristics of meat. There are four main determents of meat quality at the consumer level: color **(Priolo et al., 2001)**, flavor intensity, juiciness, and tenderness **(Becker, 2000).** However, quality can also be determined more objectively through properties of the meat, like pH level **(Weglarz, 2010),** and chemical composition **(Givens, 2005).**

Proximate chemical analysis of *Triceps brachii* and *Semitendinosus* muscles showed that fat content of *Triceps brachii* muscle was significantly ($p<0.05$) higher than that of *Semitendinosus muscle* (Table 1). Even though, there were non-significant ($p<0.05$) differences in moisture, protein and ash content among investigated muscle samples. The obtained results were in agreement with **Babiker and Yousif (1990**) who found that camel *Triceps brachii* and *Semitendinosus* muscles had similar moisture and protein content. The obtained results were also similar to the results obtained by **Al-Owaimer (2000)** and **Al-Owaimer et al. (2014)** who stated that the moisture and protein content of camel meat ranged from 70 to77% and 20 to 23% respectively. However, the moisture content of investigated camel muscle were higher than that of **Al-Owaimer et al. (2014)** and **Maqsood et al. (2015)** who found that moisture content of camel muscle were 71.96% and 71.77% respectively. Moreover, the obtained fat and ash results were lower than that of **Kadim et al. (2008), Al-Owaimer et al. (2014)** and **Maqsood et al. (2015)** who established that camel muscles contain about 3.00, 4.30 and 4.82% for fat and 1.20, 1.40 and 1.50% for ash respectively.

The ultimate pH of muscle is an important parameter which determines the meat quality. The ultimate pH value of meat is influenced by many factors including pre-slaughter handling, post mortem treatments and muscle physiology **(Thompson, 2002).** The mean values of pH were non-significantly ($p<0.05$) differ between different investigated camel muscles (table 1). The mean values were 5.70 and 5.50 for *Triceps brachii* and *Semitendinosus* muscles respectively. These results were not agreed with **(Babiker and Yousif, 1990)** who reported that the mean values of pH were 5.69 and 5.72 for *Triceps brachii* and *Semitendinosus* muscles respectively.

The mean values of TBARS (mg malonaldehyde/kg) were 0.19 and 0.24 for *Triceps brachii* and *Semitendinosus* muscles respectively (table 1). It is obvious that TBARS value of *Triceps brachii* muscle was not significantly lower than that of *Semitendinosus* muscle. Generally, TBARS values of investigated camel muscles were very lower than permissible limit (0.9 mg malonaldehyde/kg). These results may be referred to low fat content **(Kadim and Mahgoub 2008**) and higher saturated fatty acids content **(Sahraoui et al., 2014; Maqsood et al., 2015)** of camel meat .

Data in table (2) indicated that there were non-significant ($p<0.05$) differences in the total soluble, sarcoplasmic and myofibrillar proteins (g%) between *Triceps brachii and Semitendinosus* camel muscles. The mean values were 7.08, 7.35& 4.23, 4.05 and 2.87, 3.30 for total soluble, sarcoplasmic and myofibilliar proteins content of *Triceps brachii* and *Semitendinosus muscles respectively*. The obtained results were lower than the results established by **(Babiker and Yousif, 1990)** who reported that the mean values were 6.76, 6.51& 11.81, 11.84 for sarcoplasmic and myofibilliar protein content in *Triceps brachii* and *Semitendinosus muscles* respectively.

It is clearly that the myoglobin content *of Semitendinosus* muscle was significantly ($p<0.05$) higher than that of *Triceps brachii* muscle (table 2). These results may be explained by the differences in physiological requirements of different muscles for myoglobin. Myoglobin quantity varies with species, sex, muscle location and physical activity **(Judge et al., 1990).** *Semitendinosus* muscle has higher iron content than *Triceps brachii* muscle **(Dawood and Alkanhal, 1995)** which indicated higher myoglobin content in hindquarter muscles. However, **Kamoun (1995)** reported that myoglobin content of camel *Triceps brachii* muscle was significantly ($p<0.05$) higher than that of *Semitendinosus* muscle where, the mean average of myoglobin content was 5.1 and 3.4 mg/g for *Triceps brachii* and *Semitendinosus* muscle respectively.

Collagen plays an important role in the meat texture. The contribution of connective tissue to the secondary toughness of meat is dependent on the quantity, type and intermolecular cross-links of collagen which are the main component of connective tissue **(Light et al., 1985)**. Results of collagen content and solubility revealed the presence of significant ($p<0.05$) differences between the two investigated muscles, where *Triceps brachii* muscle had significantly ($p<0.05$) higher collagen content and collagen solubility than *Semitendinosus* muscles (table 2). These results were in agreement with **Babiker and Yousif (1990)** who found that the collagen content of *Triceps brachii* muscle was significantly ($p<0.05$) higher than that of *Semitendinosus* muscles. The differences in collagen content and solubility between the two muscles could be attributed to the fact that each muscle within the animal body has distinctive features of collagen content and architecture **(Nakamura et al., 2003)**. From the obtained results we can concluded that collagen content of forequarter higher than hindquarter, where, muscles of forequarter contain high amount of connective tissue to withstand the animal weight.

Muscle fiber strength, connective tissue strength and tenderness of muscles, were measured by shear force **(Babiker and Yousif, 1990)**. The mean shear force value of *Triceps brachii muscle* was significantly ($p<0.05$) higher than value for *Semitendinosus* muscle (table 3). The results may be explained by higher connective tissue content of *Triceps brachii* muscle (table 2) which considered the main factor determine the shear force of the muscle. Moreover, postmortem proteolysis, intra-muscular fat, and the contractile state of the muscle are also important factors that influence meat tenderness; these factors also contribute to the differences between various muscles within the carcass **(Kemp et al., 2010).**

Meat color is the first quality attribute which affects consumers for purchasing the meat, therefore it is important to evaluate the meat color **(Judge et al., 1990)**. Assessment of color revealed that lightness (L*) value of *Semitendinosus* muscle was significantly ($p < 0.05$) higher than that of *Triceps brachii* muscle (table 3). These results were confirmed that of obtained by **Babiker and Yousif (1990)** who stated that higher lightness (L*) value was noted in *Semitendinosus* muscle. However, there were no significant differences in redness (a*) and yellowness (b*) values between the two investigated muscle samples. These slightly differences in muscles color might be due to differences in muscle myoglobin concentration where, the color of fresh meat depends mainly on the concentration of the myoglobin pigment (purplish red) and by the relative proportions of its three common forms, oxymyoglobin (bright

red) and hemoglobin (brown) **(Judge et al., 1990)**. It is noted that *Semitendinosus* muscle had the highest myoglobin content (5.23mg/g) rendering this muscle exposed for color changes which expressed as high yellowness (b*) value.

CONCLUSION

From the obtained results it can be concluded that the anatomical location of muscle play an important role in the determination of meat quality. *Semitendinosus* muscle had significantly higher myoglobin content and L* value. Even though; *Triceps brachii* muscle had significantly higher collagen content and shear force value indicating that forequarter was the tougher than hindquarter muscle. A better understanding of chemical composition of individual camel muscles would benefit the meat industry to maximize potential marketability by improving quality characteristics in camel meat.

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