

REGULAR ARTICLE

**Chemical composition of *Infraspinatus*, *Triceps brachii*, *Longissimus thoraces*, *Biceps femoris*, *Semitendinosus*, and *Semimembranosus* of Bactrian (*Camelus bactrianus*) camel muscles**

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**Abstract**

The objective of this study was to determine chemical composition of *Infraspinatus*, *Triceps brachii*, *Longissimus thoraces*, *Biceps femoris*, *Semitendinosus*, and *Semimembranosus* muscles from nine Bactrian carcasses (2-3 years of age). The left side muscles were collected and kept in a chiller (3-4°C) for 48 hrs then stored at -20°C. Chemical analyses were carried out to determine moisture, crude protein, fat (ether extract), ash, essential and non-essential element contents. The *Infraspinatus*, *Triceps brachii*, *Biceps femoris*, *Semitendinosus* and *Semimembranosus* muscles had significantly higher moisture content than *Longissimus thoraces* muscle. The range of variation in protein content among the muscles was from 17% (*Longissimus thoraces*) to 18.8% (*Semitendinosus*). The *Longissimus thoraces* muscle had significantly higher fat content than other muscles. The *Longissimus thoraces* muscle had significantly lower phosphorus, magnesium, sodium and potassium contents than *Infraspinatus*, *Triceps brachii*, *Biceps femoris*, *Semitendinosus* and *Semimembranosus* muscles. Small variation in iron, zinc, lead, cadmium, copper, cobalt and magnesium contents were found among selected muscles. This study indicated that muscle location of the Bactrian camel may have an effect on its chemical composition.

*Key words:* Bactrian camel, Chemical composition, Essential minerals

**Introduction**

Camel has been well recognized as an important meat animal in less developed parts of the world but its meat is gaining importance due to its low fat content and it is relatively rich in polyunsaturated fatty acids (Kadim et al., 2008). Meat is an essential source of protein, energy, vitamins and minerals for human nutrition. However, recently there has been a concern about the health hazards of diets containing high levels of animal fat and cholesterol. These have been identified as a cause of a wide range of health problems including obesity, cardiovascular diseases, cancer, etc. Consequently, low fat diets have been attaining more acceptability. Camel meat is considered leaner as they produce less proportions of carcass fat than other meat animals. Camel meat has a good market potential, as it could become an ideal

choice for health conscious consumers (Kadim et al., 2008). The chemical composition of camel meat is similar to meats from other species where an inverse relationship existed between the moisture and protein contents and the fat content. The chemical composition of camel meat is an important indicator of meat functionality. Moisture content of camel meat plays an important role in the keeping and eating qualities of meat (Kadim et al., 2006) whereas protein and fat contents dictate the manufacturing quality of meat.

In Kazakhstan, camel meat is consumed and preferred by the local population and camels are slaughtered regularly for social, special occasions and certain time of the year. Kazakhstan has 168,000 heads with 80% Bactrian camels (*Camelus bactrianus*). Although, the nutritive value of camel meat has recently become a growing aspect in the marketing of meat products in Kazakhstan, there is no information on its meat composition. Therefore, it is time to establish better criteria of Bactrian camel meat composition. This will be practically applicable for every region raising Bactrian camels for meat production. An efficient marketing system

Received 12 May 2012; Revised 8 June 2012; Accepted 9 September 2012; Published Online 06 December 2012

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for the Kazakhstan Meat Industry needs more information on meat composition in relation to consumers. The aim of this study was to investigate the chemical composition of *Infraspinatus*, *Triceps brachii*, *Longissimus thoraces*, *Biceps femoris*, *Semitendinosus*, and *Semimembranosus* of Bactrian camel muscles in Kazakhstan.

## Materials and Methods

### Animals and meat samples

Nine Bactrian camels (2 to 3 years of age) were slaughtered at Zhengis Sharua Kozhalygy camel farm, Kyzylorda, Kazakhstan. The *Infraspinatus*, *Triceps brachii*, *Longissimus thoraces*, *Biceps femoris*, *Semitendinosus*, and *Semimembranosus* muscle samples were dissected within 20 min postmortem. Each muscle was trimmed off external fat and transported in an insulated cool box and kept in a chiller (3-4°C) for 48 hrs for proximate analysis.

### Proximate composition

All visible fat was removed from each muscle before they were cut into small pieces. Two-hundred grams of meat sample were placed in plastic containers and then dried in a thermo freeze dryer (Modulyol-230, Milford-UK) for five days under 100-mbar pressure at -50°C. The frozen dry samples were ground using Panasonic-Mixgrinder, Model MX119N-Japan grinder in order to obtain a homogenous mass for chemical analyses. The proximate chemical composition of the muscle tissue was determined as described by Kadim et al. (2009). In brief, protein was determined using a Foss Kjeltex 2300 Nitrogen/Protein Analyzer. Fat (ether extract) was determined by Soxhlet extraction method, using petroleum ether. Ash content was determined by ashing samples in a muffle furnace at 500°C for overnight.

### Mineral composition

Evaluation of mineral levels in camel meat was carried out in two phases, digestion of samples and analyses. Stock of Co, Zn, Cu, Mn, Pb, Mg, Ca, Cd, and P standard (100mg/L) solution were purchased

from Sigma-Aldrich (Chemie GmbH, Riedstrasse 2, D-89555, Steinheim Germany), while K and Na standards (1000mg/L) solutions were obtained from Sherwood (The Paddocks, Cherry Hinton Road, Cambridge, UK). Working standard was prepared by suitable serial dilutions of stock (1000mg/L) of all standard in deionized water and in house standard reference materials used for validation of the method. Complete digestion was achieved using a CEM microwave system Model MARS 907511 (CEM Cooperation, Mathews, North Carolina, USA) with a maximum temperature of 200°C in closed polytetrafluoroethylene (PTFE) vessels. Concentrated HNO<sub>3</sub> was used for the digestion of samples. In brief 10 ml of conc. HNO<sub>3</sub> were added to each digestion vessels. They were then heated to 200°C over a 15 minutes period, and then held at 200°C for another 15 minutes. The digest obtained was collected in 100-ml volumetric flasks and made up to volume. Measurements of Co, Zn, Cu, Mn, Pb, Mg, Cd and Ca were carried out on Atomic Absorption Spectrophotometer (AAS) system type Shimadzu Model AA-6800, equipped with GFA-EX7 240V CE Graphite Furnace, HVG-1 Hydride Vapor Generator, MVU-1A Mercury Vaporizer and ASC-6100 Auto Sampler (Japan). Whereas K and Na were analysis by Sherwood Flame photometer, model 420 equipped with Auto sampler model 860 (The Paddocks, Cherry Hinton Road, Cambridge, UK) and P were analysis by Helios UV Visible Spectrophotometer, model Helios Beta (Thermo Electron Corporation, UK).

### Statistical analysis

The data were analyzed using General Linear Model's procedure (SAS, 1993) to compare the effect of muscle type (*Infraspinatus*, *Triceps brachii*, *Longissimus thoraces*, *Biceps femoris*, *Semitendinosus*, and *Semimembranosus* muscles) on proximate composition essential and non-essential elements of Bactrian camel. Significant differences between means were assessed using the least-significant-difference procedure.

Table 1. Chemical composition of Bactrian camel *Infraspinatus* (IS), *Triceps brachii* (TB), *Longissimus thoracis* (LT), *Semitendinosus* (ST), *Semimembranosus* (SM), and *Biceps femoris* (BF).

	Muscles						SEM <sup>1</sup>
	IS	TB	LT	ST	SM	BF	
Moisture (%)	78.5 <sup>b</sup>	78.4 <sup>b</sup>	72.1 <sup>a</sup>	78.0 <sup>b</sup>	79.0 <sup>b</sup>	78.5 <sup>b</sup>	0.64
Protein (%DM)	18.0	17.5	17.0	18.8	18.2	18.3	0.52
Fat (%DM)	2.5 <sup>a</sup>	3.0 <sup>a</sup>	10.0 <sup>b</sup>	2.2 <sup>a</sup>	2.0 <sup>a</sup>	2.1 <sup>a</sup>	0.57
Ash (%DM)	1.0	1.0	0.9	1.0	1.0	1.1	0.03

<sup>1</sup>SEM: standard error for the mean.

## Results and Discussion

The *Infraspinatus*, *Triceps brachii*, *Biceps femoris*, *Semitendinosus*, and *Semimembranosus* muscles had significantly ( $P < 0.05$ ) higher moisture content than *Longissimus thoracis* muscle (Table 1). With the exception of *Longissimus thoracis* muscle, no differences in moisture content between muscles in the present study is agreement with findings of Babiker and Yousif (1990), El-Faer et al. (1991), Al-Shabib and Abu-Tarboush (2004) and Alfawaz (2004). They reported that different muscles from the same animal appear to have similar moisture contents. In the present study, the difference between *Longissimus thoracis* and other muscles might be due to higher fat content of the *Longissimus thoracis* muscle. Similarly, Shehata (2005) reported that *Biceps femoris* muscle had higher moisture content (74.2%) compared with *Longissimus thoracis* muscle (69.2%) due to the higher fat content in the *Longissimus thoracis* muscle. However, the average value for moisture of *Longissimus thoracis* muscle was within the range reported for moisture (70-77%) for *Longissimus thoracis* muscle of dromedary camel (Kilgour, 1986; Babiker and Yousif, 1990; El-Faer et al., 1991; Elgasim and Alkanhal, 1992; Al-Ani, 2004; Cristofaneli et al., 2004; Kadim et al., 2009). The moisture contents of *Triceps brachii*, *Semitendinosus* and *Biceps femoris* muscles were higher than reported by Babiker et al. (1990) and Gheisari et al. (2009). Moisture is important as far as its pronounced effects on meat shelf life, processing potential and sensory characteristics (Kadim et al., 2009). The current study showed that moisture content of Bactrian camel meat was higher than dromedary camel meat.

The protein content of Bactrian camel muscles was in the range 17.0 to 18.8% (Table 1). No significant differences in protein content between the *Infraspinatus*, *Triceps brachii*, *Longissimus thoracis*, *Semitendinosus*, *Semimembranosus*, and *Biceps femoris* muscles in the present study is on line with the conclusions of others (El-Faer et al., 1991; Dawood and Alkanhal, 1995; Kadim et al., 2006). Protein contents of Bactrian camel muscles were slightly lower than those reported by Babiker and Yousif (1990) and Gheisari et al. (2009) and Kadim et al. (2006) for dromedary camel's muscles. Breed may cause slight differences in camel meat composition. Studies from Saudi Arabia (El-Faer et al., 1991; Elgasim and Alkanhal, 1992; Al-Shabib and Abu-Tarboush, 2004) reported lower protein content than those from United Arab Emirates, Iran, Sudan and Syria (Babiker and Yousif, 1990; Kadim et al., 2006, 2009; Gheisari et al., 2009; Al-Bachir

and Zeinou, 2009). However, content of *Longissimus thoracis* muscle in Bactrian camel is similar to those of dromedary *Longissimus thoracis* (16.8%) muscle (Abdelhadi et al., 2012). The difference of protein content between this study and other studies may be due to breed and age differences.

The fat content of Bactrian camel muscles ranged from 2.0 to 10.0% (Table 1). The *Longissimus thoracis* muscle had significantly ( $P < 0.05$ ) higher fat content (10.0%) than *Infraspinatus* (2.5%), *Triceps brachii* (3.0%), *Semitendinosus* (2.2%), *Semimembranosus* (2.0%) and *Biceps femoris* (2.1%) muscles. The nature of the connective tissue matrix also affects the accumulation of fat. Loosely arranged muscles such as the *Longissimus thoracis*, having parallel connective tissue strands, contained more fat than tightly compacted muscles such as *Semimembranosus*, *Semitendinosus*, or *Biceps femoris* muscles. The latter's connective tissue strands are thicker and more tightly structured, thus physically preventing excess fat accumulation. Such difference between muscles can be explained by location of muscles and nature of connective tissue. No significant differences in the fat content between *Infraspinatus*, *Triceps brachii*, *Semitendinosus*, *Semimembranosus* and *Biceps femoris* muscles were supported by findings of Kadim et al. (2006, 2009, 2011), Ghaisari (2011), Gheisari and Motamedi (2010), Al-Bachir and Zeinou (2009), Gheisari et al. (2009), Sallam and Morshedy (2008), Afawaz (2004), Al-Sheddy et al. (1999) and Al-Shabib and Abu-Tarboush (2004). They concluded that slight differences in the fat content were found in different cuts and muscles with significant variation in fat content between *Longissimus thoracis* muscles and other meat cuts. Fat contents of Bactrian camel meat were higher than dromedary camel meat (Babiker et al., 1990; Gheisari et al., 2009). Camel meat contains less fat than beef, lamb and goat meat (Kadim et al., 2008). This makes the camel meat a healthy option and advantageous in special diets.

The ash content in the Bactrian camel muscles was reported in the range 0.90 to 1.10% (Table 1). Many studies found that the ash content vary with muscles and meat cuts (Babiker and Yousif, 1990; Dawood and Alkanhal, 1995; Gheisari et al., 2009). Ash contents for *Longissimus thoracis*, *Triceps brachii*, *Semitendinosus*, and *Biceps femoris* Bactrian muscles were slightly lower than dromedary camel meat (Babiker et al., 1990; Kadim et al., 2006, 2009; Abdelhadi et al., 2012). Camel meat has relatively lower ash content than beef, lamb and goat meat (Elgasim and Alkanhal, 1992; Gheisari et al., 2009).

Table 2. Essential and non-essential element levels (g/100g DM) of Bactrian camel *Infraspinus* (IS), *Triceps brachii* (TB), *Longissimus thoracis* (LT), *Semitendinosus* (ST), *Semimembranosus* (SM), and *Biceps femoris* (BF).

	Muscles						SEM <sup>1</sup>
	IS	TB	LT	ST	SM	BF	
	Essential/nutritional elements						
Phosphorus	3.32 <sup>b</sup>	3.72 <sup>b</sup>	2.29 <sup>a</sup>	3.97 <sup>b</sup>	3.66 <sup>b</sup>	3.74 <sup>b</sup>	0.131
Calcium	0.05	0.05	0.05	0.05	0.05	0.05	0.002
Magnesium	2.48 <sup>a</sup>	3.03 <sup>ab</sup>	2.51 <sup>a</sup>	3.5 <sup>b</sup>	3.27 <sup>b</sup>	3.45 <sup>b</sup>	0.143
Sodium	5.01 <sup>b</sup>	4.57 <sup>b</sup>	3.59 <sup>a</sup>	5.78 <sup>c</sup>	4.93 <sup>b</sup>	5.16 <sup>b</sup>	0.154
Potassium	74.4 <sup>b</sup>	80.5 <sup>b</sup>	36.9 <sup>a</sup>	80.0 <sup>b</sup>	77.7 <sup>b</sup>	73.5 <sup>b</sup>	1.53
Iron	0.06	0.08	0.05	0.08	0.12	0.08	0.009
Zinc	0.02	0.02	0.01	0.02	0.02	0.02	0.001
Copper	0.002	0.002	0.004	0.002	0.002	0.001	0.0005
Cobalt	0.002	0.002	0.004	0.003	0.003	0.003	0.0006
Magnesium	0.003	0.002	0.003	0.003	0.003	0.003	0.0007
	Toxic elements						
Lead	0.03	0.03	0.03	0.03	0.03	0.02	0.004
Cadmium	0.03	0.05	0.03	0.03	0.03	0.03	0.008

<sup>1</sup>SEM: standard error for the mean.

The present study indicated that no significant differences among the six muscles on essential or non-essential element contents (Table 2). Minerals are generally classified as either that are required for growth and optimal health or toxic elements, which poses health risk to organism. Both the deficiency and excess intake of essential elements as well as exceeding the safe limits of toxic elements can be detrimental to human health.

Muscles contained high levels of potassium, followed by sodium, phosphorus, magnesium and calcium. Comparison of phosphorus, magnesium, sodium and potassium contents of Bactrian camel muscle samples showed significant differences between selected muscles (Table 2). Phosphorus is the third most abundant element in Bactrian camel meat (2.29-3.97 mg/100g). The *Longissimus thoracis* muscle had significantly ( $P<0.05$ ) lower phosphorus content than other muscles, which it may be due to biological role of each element in muscle physiology. Calcium content (mg/100g) for dromedary camel meat cuts were reported to be in the range of 1.33- 11.48 (Faer et al., 1991; Elgasim and Alkanhal, 1992; Dawood and Alkanhal, 1995; Rashed, 2002; Badiei et al., 2006; El- Kadim et al., 2009). However, the level of variation between the current study and the previous studies may be due to physiological factors, which play a major role in determining the calcium contents in camel meat. Small variation in calcium content was reported among different meat cuts. The variation between four to six different meat cuts in dromedary camel were 19-27% (El-Faer et al., 1991; Dawood and Alkanhal, 1995; Rashed, 2002) whereas up to 144%

variation in calcium content can be observed among different meat cuts from different studies (Kadim et al., 2008). Magnesium is another essential mineral for the normal contractions of muscles. The present study showed that *Infraspinus* (2.48 g/100g) and *Longissimus thoracis* (2.51 g/100g) muscles contained significantly lower magnesium than *Triceps brachii* (3.03 g/100g), *Semitendinosus* (3.5 g/100g), *Semimembranosus* (3.27 g/100g) and *Biceps femoris* (3.45 g/100g) muscles. Meat from dromedary camels appears to have lower magnesium content (0.01 mg/100g) across four different meat cuts (El-Faer et al., 1991; Elgasim and Alkanhal, 1992). However, meat from camels in dromedary camel appears to have higher magnesium content and the concentration varied among different meat cuts (Rashed, 2002). Sodium content in camel meat was in the range of 3.59 – 5.78 mg/100g (Table 2). The *Longissimus thoracis* (3.59 g/100g) muscle had significantly lowest sodium content while the *Semitendinosus* (5.78 g/100g) muscle had the highest content comparing to other muscles. Similar conclusion was reported by Elgasim and Alkanhal (1992); Rashed (2002) and Kadim et al. (2006). They found that loins region had the lowest sodium content among the different camel meat cuts tested. Potassium has a bioactive role in muscle function, particularly energy metabolism and neuromuscular excitability (Allen, 1989). The *Longissimus thoracis* muscle had significantly ( $P<0.05$ ) lower potassium content than other five muscles tested. Although, no significant difference for micro elements among the selected muscles in the present study, zinc, lead

cadmium, copper, cobalt and magnesium levels were within the range of dromedary camels (El-Faer et al., 1991; Dawood and Alkanhal, 1995; Rashed, 2002; Kadim et al., 2006). Iron content in camel meat (1.16-3.39 mg/100g) varied among different meat cuts (El-Faer et al., 1991; Dawood and Alkanhal, 1995; Rashed, 2002) which is expected due to the different physiological requirements of myoglobin of different muscles. As with other red meat species, meat cut containing oxidative muscles (*Semitendinosus*, *semimembranosus* and *biceps femoris*) has higher iron content than glycolytic muscles (*Longissimus thoracis*). However, the range of iron content in the present study was low compare to other camel study, which may be due to different methods of determination, age and location of meat samples.

### Conclusion

The composition of Bactrian camel meat is similar to other red meats, but it can be considered as a healthy option due to the low fat content of the meat. A better understanding of chemical composition of individual camel muscles may benefit the meat industry to maximize potential marketable by improving nutritive value of camel meat.

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