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CONCENTRATIONS OF NUTRIENTS IN SIX MUSCLES OF BACTRIAN (*Camelus bacterianus*) CAMELS

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ABSTRACT

Differences between muscles in concentrations of proximate composition, minerals, cholesterol, amino acids, fatty acids and vitamins for the *Infraspinatus* (IS), *Triceps brachii* (TB), *Longissimus thoraces* (LT), *Biceps femoris* (BF), *Semitendinosus* (ST) and *Semimembranosus* (SM) muscles of 9 bactrian camels (2-3 years of age) were investigated. The composition of lean bactrian camel was shown to be highly desirable with a high nutrient density for many nutrients. Although lean meat samples from six muscles were similar in most nutrients detected, several significant differences were found. LT muscle had significantly higher dry matter and fat% than other muscles. The IS and LT muscles had significantly ($P<0.05$) higher cholesterol levels than TB, BF, ST and SM muscles. Concentrations of Myristic (C14:0), Palmitic (C16:0), Palmitoleic (C16:1) and Oleic acids (C18:1n9) were significantly ($P<0.05$) different between muscles. The LT muscle contained a significantly lower proportion of mono-unsaturated fatty acids than other muscles. The ratio of polyunsaturated to saturated fatty acids, which ranged from 0.40 to 0.50, was ≥ the minimum ratio of 0.40 recommended to reduce the risk of coronary diseases in humans. The amino acids and vitamin composition were similar for meat sample from six muscles. Consuming 150 to 200 g of camel meat will cover the daily requirement for an adult man weighing 70 kg for essential amino acids. This information on the nutritional value of camel meat is of great importance for promotion of the product.

Key words: *Camelus bacterianus,* camel, meat composition, meat quality, nutritive value, vitamins

Camel farming for meat production is growing due to its nutritional and health aspects. Camel meat can be considered as a new alternative healthy meat for human consumption (Bekhit and Farouk, 2013; Abrhaley and Leta, 2018). This may lead to an increase in camel meat consumption but the level of consumption is currently not comparable to that of other meats (Kadim *et al,* 2008). Meat is generally considered as a major source of fat in human diets, which is associated with various cancers and coronary heart diseases. Recently, there has been a lot of interest in camel meat because it contains relatively higher concentrations of long chain n-6 and n-3 polyunsaturated fatty acids than cattle and sheep meats (Kadim *et al,* 2008). Moreover, camel meat is believed to have medicinal properties (Bin Saeed *et al,* 2005; Kurtu, 2004; Abrhaley and Leta, 2018). Published evidence suggests that quality characteristics and nutritive value of camel meat are not much different from beef when slaughtered at comparable ages (Elgasim *et al,* 1987; Tandon *et al,* 1988; Kadim *et al,* 2011; 2013). However, utilisation of camel meat is hampered by a lack of knowledge about its nutritive value overall and within individual muscles. Few studies have been carried out on this aspect (Kadim *et al,* 2006, Kadim *et al,* 2008, 2011, 2013). The available information is mainly related to just a few camel muscles (Rawdah *et al,* 1994; Al-Bachir and Zeinou, 2009; Kadim *et al,* 2011; 2013).

Characteristics of individual muscles in beef, pork and sheep have identified certain muscles that can be marketed more successfully on an individual basis (Jones *et al,* 2000; 2001; Tschirhart-Hoelscher *et al,* 2006). Marketing on an individual-muscle basis may increase the demand for camel products, but such a marketing system requires more information

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on the nutritive value of individual muscles. Such information should permit more efficient marketing of camel meat and may encourage camel farmers to produce more attractive cuts with known quality characteristics.

In Kazakhstan, camel meat is one of the most important animal protein sources and is preferred in some parts of the country over meat from other animal species due to its quality and availability at affordable prices. However, there are no detailed studies in the nutritive value of the bactrian camel meat. The aim of this study was to determine the concentrations of minerals, cholesterol, fatty acids, amino acids and vitamins of *infraspinatus* (IS), *triceps brachii* (TB), *longissimus thoraces* (LT), *biceps femoris* (BF), *semitendinosus* (ST) and semimembranosus (SM) muscles of bactrian camels in Kazakhstan, with the aim to improve camel meat acceptability to consumers by providing more information about it.

Materials and Methods

Animals and Meat Samples

Nine intact male bactrian camels (2-3 years of age) were slaughtered at Kyzylorda camel farm in Kazakhstan. The IS, TB, LT, BF, ST and SM muscles were excised from the left side of each carcass within 20 min of slaughter. Each muscle was trimmed of external fat and the loose connective tissue and kept in a chiller (3-4°C) for 48 hrs and then stored at -20°C for subsequent nutritional composition analysis. Two-hundred grams from each muscle were cut up into small pieces and placed in plastic containers and dried in a Thermo freeze dryer (Thermo-Model Modulyo-23, Milford-UK) for 5 days under 80-mbar pressures at -60°C. They were then ground in a Cyclotech 1093 sample mill with a 0.5-mm screen and were placed in sealed plastic bags until analysed.

Proximate analysis

The chemical composition of the muscle tissue was determined by proximate analysis according to the standard methods of the AOAC (2000). The moisture was determined by weighing 200 g meat sample before and after drying in a thermo freeze dryer for 5 days (AOAC 950.46). Protein was determined using a Foss Kjeltec 2300 nitrogen/ protein analyser (method 976.95). Fat was determined by Soxhlet extraction method using petroleum ether (method 920.39). Ash content was determined by ashing samples in a muffle furnace at 500°C for 24 h (method 942.05).

Mineral Composition

Macro and micro mineral profiles of bactrian camel meat samples were estimated following 2 phases, digestion and analyses. Standard (1000 mg/L) solutions (Sigma-Aldrich; Chemie GmbH. Steinheim Germany and Sherwood: Paddocks, Cambridge, UK) were used to determine Ca, P, Mg, Na, K, Fe, Zn and Cu of the muscles. Digestion of 1 g freeze dried meat samples was completed 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. Ten ml of concentrated. HNO_3 was added to each digestion vessels and heated to 200°C over 30 minutes period. The digest obtained was collected in 100-ml volumetric flasks and made up to volume. Measurements of minerals (g/100g DM) were carried out on an 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).

Cholesterol Content

The cholesterol contents of muscles were determined according to a modified method of Bohac *et al* (1984). Briefly, 2 g of extracted fat sample from each muscle were saponified with 2 ml of 50% potassium hydroxide and 3 ml of 95% absolute alcohol and heated for complete solubilisation at 60°C for 15 min. When the mixture cooled, 5 ml of distil water were added and shaken for 1 min using vortex mixture. The non-saponifiable fraction was extracted 3 times using 5 ml of hexane. Three ml aliquots of hexane extracts were dried under a nitrogen flow at 50°C. The dried extracts was re-suspended in 3ml glacial acetic acid and thoroughly mixed then 2ml of $FeCl_3$ (Colouring solution) was added and the solution were allowed to stand for 30 min and the resultant colour was read at 565 nm using spectrophotometer model, Helions BETA, Thermo Spectronic, Cambridge, UK.

Fatty acid composition

The intramuscular fat content of each muscle sample was extracted following the method 991.36 (AOAC, 2000) using petroleum ether for 8 hrs. The fatty acid profiles were quantified following the method described by Ayerza *et al* (2002). Briefly, 0.2 g of this extracted fat sample was mixed with 4 ml of chloroform: methanol (2:1), 1 ml of internal standard

[henecosanoic acid (C21)] was added and the mixture was left overnight at -20°C. The mixture was then dried in a rotary evaporator at 40°C, suspended in 6 ml of diethyl ether, transferred to a test tube, dried under a stream of nitrogen, reconstituted with 1 ml of NaOH (0.5M), heated for 15 min at 100°C and then cooled in water. Two ml of BF_3/CH_3OH was added, mixed thoroughly, heated for 5 min at 100°C and cooled. One ml of hexane and 2 ml of distilled water were added, mixed for 15 seconds and centrifuged at 3000rpm for 5 min. The upper hexane layer was collected and extracted with 1 ml of hexane. Hexane extracts were passed over anhydrous Na_2SO_4 and transferred into a 2 ml GC vial, GC Agilent 6890N with flame ionisation detector were used to quantify fatty acids. Fatty acids were separated with a SUPELCO SP-2560 (100 m length x 0.250 mm I.D. x 0.200 um film thickness). Helium was used as a carrier gas at a constant flow of 1.0 ml/min. The injection and detector temperatures were 250°C and 255°C, respectively. The oven temperature programme was 80°C at a rate of 4°C / min–240°C held for 15 minutes. Fatty acids were identified by comparison of their retention times with that of the Heneicosanoic acid internal standard (ISTD). The total fatty acid content was calculated as mg/g = (area of sample/area of ISTD) × (amount of ISTD (mg) /sample weight (g) = mg/g. Sigma-Aldrich, CH9471, Buches, 081/755-25-11 (Germany) was used as standards to identify individual fatty acids. The long-chain n-3 PUFAs (viz EPA, DPA and DHA) have not been measured.

Amino acid analysis

Total amino acid composition of meat samples was determined using modified procedures from 3 methods (Maria and Toldra, 1991; White *et al,* 1986 and Wu *et al,* 2009. One gram of freeze-dried muscle sample was transferred to a 250 mL screw-cap bottle, then 25 µL of 2.5 mM Nle (L-Norlencine TLc rad, Sigma Aldrich, Biotech GmbH, 82024 Tantkirchen, Germany) and 10 mL of 6M hydrochloric acid phenol reagent were added to each bottle. The contents of each bottle were lightly vortexed and then placed in an oven (Oven 300 plus series, Gallenkamp, Midlands, Betton Road, Leicester) at 110°C for the 1st hour, the bottle cap was opened and then closed for the next 23 hr in the oven. After hydrolysis, the bottle was cooled down to room temperature and the cap carefully opened. The content was filtered into 50 mL volumetric flask, made up to 50 mL with HPLC water (Water Chromasolv for HPLC, Sigma Aldrich, Biotech GmbH, 82024 Taufkirchen, Germany) and 2 ml of the extract was poured into a 2 ml vial. Then 20 µL of methanol-0.5% sodium acetate triethanolamine (TEA, T58300 Sigma-Aldrich) (2:2:1) was added to each sample and dried again under vacuum. Twenty µL of methanol-water TEA-phenylisothiocyanate (PITC,139742 Sigma-Aldrich) (7:1:1:1) was added to each sample, the bottle was sealed, then vortexed and left to stand for 20 min at room temperature and again dried under vacuum. Finally, 500 µL of 5 mM sodium phosphate, pH 7.6, containing 5% acetonitrile were added to each sample to dilute and the liquid sample was filtered through a 0.22 µm membrane (Sartorius stedim Biotech GmbH, 37070 Gottingen, Germany) before injection. Total amino acids profile were analysed using a Dionex UltiMate 3000 High Performance Liquid Chromatography (HPLC) System with Diode Array Detector, equipped with a Dual Gradient Pump DGP-3600SD, an Inline-3000TSL Split Loop Auto-sampler, Thermostatted Column Compartment TCC-3000RS, Solvent Rack with Degasser SRD-3600, Thermostatted Column Compartment TCC-3000SD and controlled with Chromoleon 7, version 7.1. A Dionex Acclaim, 120 - C18 (3 µm particle size) column (3×150mm) (Thermo Scientific, Waltham, MA, USA). The mobile phase A was 0.14 M sodium acetate containing 0.5 mL/L of TEA adjusted to pH 6.4 with glacial acetic acid. The mobile phase B was 60:40 acetonitrile-water and filtered through a 0.45µm membrane. The temperature of the column oven was 40°C. The flow rate was 0.8 mL/min; the gradient program was as follows: the initial flow rate was 10% B; at 6 min, linear change to 12.5% B; at 32 min, linear to 58% B; at 33 min, step to 100% B; wash for 8 min and re-equilibrate at 10% B over 20 min before a new injection. The amount of individual amino acid in the sample was calculated by dividing the peak area of each amino acid by L-Norleucine butyric acid (internal standard), which was used to correct for losses during the hydrolysis analysis steps.

Vitamin determination

The water and fat soluble vitamin contents of muscle samples were determined using HPLC. All the chemicals and reagents used were of the highest purity available and purchased from Sigma-Aldrich (Chemie Gm6H Steinheim, Germany). Forty grams of fresh meat sample were mixed with 20 ml of hot water (100°C and blended (Black and Decker blender, model SC300,UK) to obtain an homogeneous sample and transferred to 100 mL amber glass bottle that was sealed. The bottle were placed in a boiling water bath

(100°C) for 30 min. Eight g of boiled sample were placed into a 50 ml centrifuge tube and 1 g of TCA was added and mixed thoroughly and centrifuged at 3000 rpm for 10 min to separate the two phases. Then 3 ml of 4% TCA were added to the upper layer (acid extracts) mixed and centrifuged at 3000 rpm for 10 min. The solid phase was discarded and the two acid extracts were combined and placed at −20°C for 10 min. The acid extracts were centrifuged at 4000 rpm for 5 min and placed at −20°C for 5 min. The layer of the fat was removed with a spatula and the acid extract was centrifuged again. Then the extract was filtered through a 0.45 µm filter before being injected into the HPLC. The standard solutions L-methionine 200 mg/L, ascorbic acid 600 mg/L, vitamin B_6 200 mg/L, vitamin B 200 mg/L and Riboflavin 2mg/L were prepared using eluent A which consisted of Potassium dihydrogen phosphate (0.005 M) and 5% v/v acetonitrile (HPLC grade) and adjusted to 5.6. pH Sonication and heating was used to prepare folic acid 2 mg/L and Riboflavin 2 mg/L, then both sets of standards were mixed and filtered through a 0.2 µm membrane filter prior to injection into the HPLC column. The vitamins were separated as described by Lebiedzinska *et al* (2007) except that the Acclaim C18 column 3 × 150 mm (µm particle size) was used. The mobile phase consisted of potassium dihydrogen phosphate (0.005M)-acetonitrile (5%) and potassium dihydrogenphosphate (0.005M)- all to 50%.

Statistical Analysis

Statistical analysis was carried out using the analysis of variance procedure (Ott, 1993) to evaluate the effect of muscle type (*infraspinatus, triceps brachii, longissimus thoraces, biceps femoris, semitendinosus* and *semimembranosus*) on proximate analysis, minerals, cholesterol, fatty acids, amino acids and vitamin concentrations. A General Linear Model procedure (PROC GLM; SAS, Institute, Inc., Cary, NC, USA, 1993) was used. A nested ANOVA model was used in which concentration of nutrients was nested within each muscle within each animal. Animal was used as the main plots and muscles as the subplots in split plot design. All statistical tests of LSM were performed for a significance level P<0.05. Significant differences between means were assessed using the least-significant-difference procedure.

Results and Discussion

Effect of type of muscle on chemical composition

This study revealed that variation between 6 muscles in certain proximate composition may be due to muscle physiological function and locations (Table 1). The moisture percentage of the IS, TB, ST, BF and SM muscles were significantly (P<0.05) higher than the value of LT muscle. The importance of moisture content in camel meat is in its marked effects on its shelf-life, processing potential and quality characteristics. Usually consumers prefer juicy over dry meat. There were no significant differences in moisture: protein ratio between the muscles. This study indicated that camel muscles content high dry matter to protein ratio, which reflects the suitability of camel meat for processing (Forrest *et al,* 1975). Similarly, Abdelhadi *et al* (2017) found dromedary camel LT contained high protein ratio. The LT muscle had significantly (P<0.05) higher fat percentage than other muscles possibly because of morphological attachment of LT to the hump (Babiker and Yousif, 1990). Kadim *et al* (2013) reported similar conclusion in dromedary camel muscles. These findings favour marketing of certain individual camel muscle due to its lower fat content. The ash content ranged from 0.9% for LT muscle to 1.1% for BF muscle with no significant differences between muscles.

Effect of type of muscle on mineral composition

The mineral composition of IS, TB, LT, ST, SM and BF muscles of bactrian camel are grouped into macro- and micro-mineral contents in table 2. There were no significant differences in calcium content between the 6 muscles. Similarly, Kadim *et al* (2013) reported no differences in calcium levels between 6 dromedary camel muscles. Insignificant variations in calcium content were also reported between different dromedary meat types (Badiei *et al,* 2006; Rashid, 2002; Elgasim and Alkanhal, 1992). However, calcium level in bactrian meat appears to be markedly higher than that in the Dromedary (Badiei *et al,* 2006; Rashed, 2002; Kadim *et al,* 2009).The level of variation between the bactrian and dromedary meats may be due to physiological factors such as adaptation to two different extreme low and high environmental temperatures with variation in type of feed intake, which may play a major role in determining the calcium contents in camel meat.

The LT muscle had significantly (P<0.05) lower phosphorus contents than other muscles, which might be due to biological role of each element in muscle physiology and function. El-Faer *et al* (1991) reported that the leg and shoulder dromedary muscles have slightly higher phosphorus than ribs muscles. The range levels of phosphorus content in bactrian muscles (272 to 393 mg/100g) were higher

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

Parameter	Muscle						
	IS	TB	LT	ST	SM	BF	SEM
Number of animals	9	9	9	9	9	9	
Moisture%	78.5[b]	78.4[b]	72.1[b]	78.0[b]	78.8[b]	78.5[b]	0.08
Protein%	18.0	17.6	17.0	18.8	18.2	18.3	1.49
Intramuscular fat%	2.5[a]	3.0[a]	10.0[b]	2.2[a]	2.0[a]	2.1[a]	1.41
Ash%	1.0	1.0	0.9	1.0	1.0	1.1	0.09
Moisture: protein	4.36	4.45	4.24	4.15	4.33	4.29	0.49

SEM: standard error for the mean. Means in the same row with different superscripts are significantly different (P<0.05).

Table 2. Macro- and micro-mineral contents of Bactrian camel *Infraspinatus* (IS), *Triceps brachii* (TB), *Longissimus thoracis* (LT), *Semitendinosus* (ST), *Semimembranosus* (SM) and *Biceps femoris* (BF).

	Muscle						
	IS	TB	LT	ST	SM	BF	SEM
Macro-mineral (mg/100g fresh tissue)							
Phosphorus	373[b]	375[b]	272[a]	390[b]	389[b]	393[b]	43.5
Calcium	13.7	13.4	14.5	14.02	14.7	13.9	9.87
Magnesium	37[a]	41a[b]	34[a]	44[b]	44[b]	45[b]	4.25
Sodium	149[b]	146[b]	135[a]	157[c]	151[b]	150[b]	19.2
Potassium	797[b]	803[b]	651[a]	804[b]	800[b]	799[b]	32.1
Micro-mineral (mg/100g fresh tissue)							
Iron	3.25	3.95	2.85	3.89	3.95	3.84	1.16
Zinc	5.72	5.61	4.88	5.74	5.69	5.78	1.59
Copper	4.11	4.01	4.41	3.89	3.95	3.91	0.95

SEM: standard error for the mean. Means in the same row with different superscripts are significantly different (P<0.05).

than the levels in the similar dromedary muscles (Bekhit and Farouk, 2013). The LT and IS muscles contained significantly (P<0.05) lower magnesium contents than ST, SM and BF muscles. In general, bactrian muscles appear to contain higher magnesium levels in comparison to dromedary camel muscles (Bekhit and Farouk, 2013). The sodium contents were significantly (P<0.05) higher in ST muscle and lower in LT within the muscles studied. The average of the sodium content in the bactrian muscles (148 mg/100 g) appears to be lower than the values found in dromedary muscles (Bekhit and Farouk, 2013). Similarly, Elgasim and Alkanhal (1992), Rashed (2002) and Kadim *et al* (2006) found that the loin region had the lowest sodium content among the different dromedary meat cuts studied. The potassium content was significantly (P<0.05) lower in the LT muscle (651 mg/100 g) than in other muscles. However, there were no differences between IS, TB, ST, SM and BF muscles, with values ranged between 797 to 804 mg/100 g. The potassium content in Bactrian LT muscle was greatly higher compared with value reported in dromedary muscle (Bekhit and Farouk, 2013).

There were no significant differences in micro elements between the muscles in the present study. Iron, zinc and copper levels were within the range of dromedary camels (Bekhit and Farouk, 2013). Similarly, Dawood and Alkanhal (1995) found small variations in zinc contents between different dromedary muscles. On the other hand, El-Faer *et al* (1991) and Rashed (2002) found large variations in between dromedary muscles. Copper contents in the dromedary meat ranged between 0.04 to 0.26 mg/100g (Bekhit and Farouk, 2013), which was lower than in the Bactrian meat. The foreleg of dromedary camel contained higher copper concentrate than other meat cuts (Rashed, 2002). Small variations in iron content in the Bactrian muscles might be due to the different physiological requirements of myoglobin of different muscle functions. Similar conclusions were reported by Rashed (2002), Kadim *et al* (2006, 2008; 2013) for dromedary muscles. However, the range of iron content in the present study was lower

that reported for the dromedary camel (Bekhit and Farouk, 2013). This may be due to different methods of analysis, age or location of meat samples. As with other red meat species, meat cuts containing oxidative muscles (e.g. leg and neck) has higher iron content than glycolytic muscles. Iron deficiency is the most prevalent nutritional disorder in the developing countries. The level of iron (haeme and non-haeme iron) in camel meat is of great importance due to the variation in iron bioavailability for human nutrition (Lombardi-Boccia *et al*, 2002).

Table 3. Cholesterol content (mg/100g) of the *Infraspinatus, Triceps brachii, Longissimus thoraces, Semitendinosus, Semimembranosus* and *Biceps femoris* muscles of bactrian camels (n = 9).

Muscle	Cholesterol level (mg/100)	SEM
Semimembranosus	43.2[a]	4.18
Infraspinatus	60.0[b]	3.94
Semitendinosus	49.0[a]	4.18
Triceps brachii	53.0[a]	3.88
Longissimus thoraces	59.1[ab]	4.23
Biceps femoris	49.7[a]	3.94
Average	52.3	

SEM: standard error for the mean. Means in the same column with no superscripts or with a common superscript letter are not significantly different (P < 0.05).

Effect of type of muscle on cholesterol content

Statistical analysis showed that the IS muscle had significantly (P<0.05) higher cholesterol contents than LT, TB, BF, ST and SM muscles (Table 3). The cholesterol concentration of the muscles was in the following order: IS >, LT > TB > BF > ST > SM. The small variation in cholesterol contents between muscles might be due to the amount of intramuscular fat and/or muscle fibre types. There is a variation between the 6 muscles in the amount of lipid and proportion of muscle fibre types (data not presented). Differences in muscle fibre types and intramuscular fat content have been reported to cause differences in cholesterol content of meat collected from different anatomical locations (Dinh *et al,* 2011). Oxidative muscle fibres (Type I, red muscle fibre types), smaller in diameter and contained high lipid tend to have more cholesterol (Alasnier *et al,* 1996). The range of cholesterol contents in the present study were similar to those reported by El-Magoli *et al* (1973) were 0.50 mg/100 g in the dromedary *longissimus dorsi* muscle. The current study supports the earlier finding that camel meat contained lower cholesterol levels than beef and lamb (Abu-Tarboush and Dawood, 1993; Elgasim and Elhag, 1992). The cholesterol contents in different Bactrian muscles in the current study were lower than those in lamb (Rowe *et al,* 1999), goat (Pratiwi *et al,* 2006), beef (Costa *et al,* 2006; Costa *et al,* 2009), chicken (Piironen *et al,* 2002; Rule *et al,* 2002) and deer (Polak *et al,* 2008) muscles. On the basis of a daily consumption of a 200 g steak, trimmed of all visible fats, except for intramuscular fat, camel meat provides 116 mg of cholesterol which represents 38% of the maximum daily cholesterol recommendations (<300 mg/day) (USDA, 2012).

Differences between muscles for intramuscular fatty acid composition

This study presented the total fatty acid content of muscles with a number of non-significant variables showing the relative amounts of different classes of fatty acids and individual fatty acids (Table 4). Palmitic acid (C16:0) was the most abundant saturated fatty acid in bactrian meat intramuscular fat with values of 55.6% followed by stearic acid (18:0) with values of 21.0% and myristic acid (C14:0) with values of 17.8% of total intramuscular saturated fatty acids. Similar conclusions were reported by Kadim *et al* (2011; 2013), Sajid *et al* (2015) and Abdelhadi *et al* (2017). While oleic acid (C18:1n9c) was the main monounsaturated fatty acids followed by linoleic acid (C18:2n6). The highest Palmitic acid (C16:0) values were found in TB and BF muscles, with values of 56.7 and 57.7%, respectively. Similar results were reported by Rawdah *et al* (1994); Al-Bachir and Zeinou (2009); Kadim *et al* (2011, 2013) and Abdelhadi *et al* (2017) for dromedary camel muscles.

The predominant monounsaturated fatty acids was oleic acid (C18:1n9), at levels around 83.6% of the total intramuscular monounsaturated fatty acids. Similar proportions were reported in the dromedary meat (Rawdah *et al,* 1994; Al-Bachir and Zeinou, 2009; Kadim *et al,* 2011, 2013; Abdelhadi *et al,* 2017). The lowest values were found in ST (82.1%) and TB (82.7%) muscles and the highest in LT (85.6%) and SM (84.3%). Kadim *et al* (2013) also found that the level of oleic acid was higher in LT muscle than the current study. Correlation test indicated that MUFA content was positively related (P<0.01) to C18:1n−9 (r=0.99).

Linoleic acid (C18:2n6) was the predominant polyunsaturated fatty acid in bactrian meat with an average of 69.2% of total intramuscular polyunsaturated fatty acids. The highest values were in BF (71.1%), IS (70.4%), TB (69.3%) and LT (69.3%) muscles. In agreement with the present findings, Rawdah *et al* (1994); Kadim *et al* (2013) and Abdelhadi *et al* (2017) found that more than 50% of

Table 4. Fatty acids composition of the *Infraspinatus* (IS), *Triceps brachii* (TB), *Longissimus thoraces* (LT), *Semitendinosus* (ST), *Semimembranosus* (SM) and *Biceps femoris* (BF) muscles of the Bactrian camel.

Fatty acid (% of total fatty acids)	Muscle						
	SM	IS	ST	TB	LT	BF	SEM
Saturated fatty acids (SFA)							
Lauric acid (12:0)	0.22	0.22	0.22	0.24	0.25	0.21	0.037
Myristic acid (14:0)	7.40	8.59	8.42	8.49	8.30	7.85	0.334
Pentadecanic acid (15:0)	0.53	0.62	0.52	0.58	0.55	0.53	0.182
Palmitic acid (16:0)	25.1	24.0	25.8	26.1	25.8	26.9	2.754
Margaric acid (17:0)	0.68	0.76	0.74	0.86	1.02	0.66	0.828
Stearic acid (18:0)	8.99	8.74	7.19	9.30	13.1	10.1	3.892
Arachidic acid (20:0)	0.19	0.17	0.17	0.19	0.22	0.18	0.078
Docosanoic acid (22:0)	0.04	0.04	0.04	0.04	0.04	0.04	0.002
Mono-unsaturated fatty acids (MUFA)							
Tetradecenoic acid (14:1)	0.24	0.25	0.24	0.20	0.12	0.20	0.112
Palmitoleic acid (16:1)	4.65	5.17	5.36	5.02	3.69	4.72	2.115
Heptadecenoic acid (17:1)	0.63	0.73	0.65	0.65	0.61	0.55	0.212
Oleic acid (C18:1n9)	29.4	30.2	28.9	28.4	26.0	28.2	3.112
Poly-unsaturated fatty acids (PUFA)							
Linoleic acid (C18:2n6)	14.7	13.9	14.4	13.6	14.1	13.2	1.783
α-Linolenic acid (C18:3n3)	1.22	1.26	1.19	1.25	1.19	1.10	0.412
Eicosadienoic acid (C20:2)	0.49	0.57	0.48	0.57	0.60	0.56	0.121
Eicosatetraenoic (C20:3n6)	0.75	0.46	0.52	0.69	0.75	0.68	0.102
Arachidonic acid (C20:4n6)	4.60	3.50	3.32	3.41	3.69	3.06	0.895
Total SFA	43.4	44.0	43.3	46.0	49.3	47.8	5.639
Total MUFA	34.8	36.3	35.2	34.3	30.3	33.6	3.271
Total PUFA	21.8	19.7	21.5	19.7	20.3	18.6	2.523
PUFA:SFA	0.50	0.45	0.50	0.43	0.41	0.40	0.055

SEM: standard error for the mean.

the polyunsaturated fatty acids in the dromedary meat was linoleic acid. The second most important polyunsaturated fatty acid in dromedary camel muscles is α-linolenic acid (18:3n-3). The present α-linolenic acid (18:3n-3) values were lower than those in the dromedary muscles reported by Kadim *et al* (2011) but higher than those reported by Kadim *et al* (2013) and Rawdah *et al* (1994). Daeau and Ferlay (1994) stated that a variable proportion of dietary 18:3n-3 to ruminant is bio-hydrogenated (85-100%), so less is available for incorporation into tissues. Bactrian muscles contained lower amounts of polyunsaturated fatty acids (Eicosadienoic acid C20:2 and Eicosatetraenoic acid C20:3n6). Important products are arachidonic acid (C20:4n-6), which have various metabolic roles. The bactrian muscles contained descent levels of arachidonic acid (C20:4n-6) with the highest level in ST muscle and lower level in BF muscle. In line with the present results, Kadim *et al* (2013) found similar range of arachidonic acid (C20:4n-6) in similar muscles in the dromedary camel. Correlation test indicated that total PUFA contents were positively related to C18:2n−6 (r=0.88).

The ratio of polyunsaturated to saturated fatty acids in bactrian camel muscles ranged from 0.40 to 0.50 (Table 4) were similar or slightly above the minimum ratio of 0.40 recommended by the British Department of Health (1994) to contribute to a reduction in the risk in coronary diseases in human. A possible explanation for these results may be due to slightly higher proportion of phospholipid in Bactrian muscle, which is associated with the 'redder' muscle fibre type profile compared with dromedary species. The present study showed that the SM and ST muscles contained the highest ratio of polyunsaturated to saturated fatty acids, while BF contained the lowest ratio. On the other hand, the ratio of all polyunsaturated to saturated fatty acids, the target for which is 0.45 or above, is much higher,

beneficially so, in Bactrian meat compared with cattle, sheep and goat meats.

Effect of type of muscle on amino acid profile of protein

There were no significant differences between Bactrian muscles on amino acid composition (Table 5). Similar results were reported by Al-Shabib and Abu-Tarboush (2004), Dawood and Alkanhal, (1995) and Elgasim and Alkanhal (1992) in the dromedary, who found that amino acid composition of the protein, remained constant in different camel commercial cuts. The most abundant essential amino acid in bactrian meat was lysine, followed by leucine, methionine, isoleucine, threonine and phenylalanine. Similar values of amino acid contents reported by Urbisinov (1992) in Bactrian camel meat and dromedary meat (Kadim *et al,* 2011 and Abdelhadi *et al,* 2017). The Bactrian muscle has a comparable essential amino acid contents to dromedary, beef, lamb and goat muscles (Al-Shabib and abu-Tarboush, 2004; Dawood and Alkanhal, 1995; Elgasim and Alkanhal, 1992; Kadim *et al,* 2011; Abdelhadi *et al,* 2017). In the essential fraction, there were small non-significant differences between muscles studied in the current study for lysine. Urbisinov (1992) found that bactrian meat contained 16.35 mg/100g of lysine, which is almost more than twice of that in the present study. The difference in lysine content between the present study and Urbisinov's study might be due to age, nutrition status, location and method of determination. The mean values obtained for lysine, leucine and methionine were higher than those obtained by Al-Shabib and Abu-Tarboush (2004), Dawood and Alkanhal (1995), Elgasim and Alkanhal (1992); Kadim *et al* (2011) and Abdelhadi *et al,* (2017) for dromedary camel muscles. Kadim *et al* (2013) reported values ranging from 7.1 to 8.6 g/100 g leucine and from 8.4 to 9.4 g/100 g for lysine in the dromedary muscles, which were similar to the values in the present study. In the present study, the essential amino acid concentrations differed between the highest and lowest values by 18.3, 31.0, 7.3, 32.4, 13.2, 11.5, 9.3, 17.6 and 10.4 between the 6 muscles for lysine, phenylalanine, leucine, histidine, methionine, isoleucine, threonine, tryptophan and valine, respectively. In the study of Al-Shabib and Abu-Tarboush (2004), the essential amino acid contents in dromedary LT and ST muscles differed by >2.1% with the exception of leucine, methionine and tryptophan, which differed by 18.5, 25.4 and 14.6%, respectively. Similarly, essential amino acid contents in the IS, LT and ST muscles differed by > 4.2% with the exception of isoleucine, methionine, threonine, tryptophan and valine which differed between 8 to 42% (Dawood and Alkanhal, 1995). On the other hand, differences in essential amino acids reported across different camel muscles ranged between 0.5 to 9.5% (Elgasim and Alkanhal, 1992; Dawood and Alkanhal, 1995; Al-Shabib and Abu-Tarboush, 2004). Tryptophan concentration in bactrian and dromedary meats (Dawood and Alkanhal, 1995) were lower than in other meats. Al-Shabib and Abu-Tarboush (2004) stated that tryptophan concentration was 1.76% of the total amino acids which was higher than the 1.28% reported for beef (Kadim *et al,* 2008). According to Casey (1993), the quality of muscle protein lies in the extent of the availability of essential amino acids such as lysine and leucine in proportions required by human. The amount of camel meat required to supply the daily requirements of essential amino acids for adults is similar to that from lamb (based on methionine which has the lowest content in meat) but is less than the amount required from beef. The lysine and leucine requirements for an adult human weighing 70 kg are 2.1 and 2.7 g/day (FAO/WHO/UNU, 2007), respectively. One hundred and fifty grams of lean bactrian meat will cover the daily requirement for lysine and leucine. The value of tryptophan in the present study was in agreement with report by Dawood and Alkanhal (1995) who found low tryptophan content in the loin and leg muscles of dromedary camel. The present study also showed that isoleucine is one of the abundant essential amino acids in the bactrian camel meat. According to the amino acid requirements for adults (Institute of Medicine, Food and Nutrition, 2002), 100 to 200 g edible portion of bactrian meat would be an excellent source of high quality proteins because it contains the major essential amino acids in an appropriate ratio. The essential amino acid requirement for an adult person weighing 70 kg is about 12.90 g/day (FAO/WHO/UNU, 2007).

Muscle type had no significant effect on non-essential amino acid composition (Table 5). Similar to the essential amino acids, non-essential amino acids contents also slightly varied between bactrian muscles. Glutamic acid (15.23-17.01 g/100 g protein), aspartic acid (9.83-10.31 g/100 g protein), arginine (6.67-7.82 g/100 g protein) and proline (4.01-5.88 g/100 g protein) were the most abundant amino acids in the non-essential fraction. The lowest mean values were in serine (3.12-4.11 g/100 g protein), tyrosine (3.45-4.15 g/100 g protein) and alanine (3.89-4.22 g/100 g protein). However,

Table 5. Amino acid compositions of Bactrian camel *Infraspinatus* (IS), *Triceps brachii* (TB), *Longissimus thoracis* (LT), *Semitendinosus* (ST), *Semimembranosus* (SM) and *Biceps femoris* (BF).

Gms	Muscle						
	IS	**SM**	**TB**	**ST**	**BF**	**LT**	**SEM**
Essential amino acids (EAA)							
Lysine	9.74	9.71	8.07	8.65	8.81	9.88	0.722
Phenylalanine	6.33	6.35	5.51	4.38	4.74	4.79	1.278
Leucine	7.43	7.25	6.89	6.91	6.82	7.08	1.325
Histidine	4.23	5.13	4.54	4.24	3.47	4.23	0.532
Methionine	6.62	7.28	6.56	7.58	6.74	7.03	0.101
Isoleucine	6.79	6.76	6.67	6.97	6.13	6.01	0.337
Threonine	5.85	5.45	5.75	6.01	5.99	5.67	0.664
Tryptophan	0.75	0.81	0.77	0.83	0.87	0.91	0.073
Valine	5.18	5.31	5.23	5.64	5.78	5.66	0.632
Total EAA	52.92	54.05	49.99	51.21	49.35	51.26	5.664
Non-essential amino acids (NEAA)							
Aspartic	9.83	10.11	10.09	10.31	10.13	9.91	1.024
Glutamic	15.23	15.94	15.67	16.34	17.01	15.99	0.893
Serine	3.12	3.81	3.78	4.11	3.87	3.89	0.217
Tyrosine	3.52	3.45	3.67	4.01	4.15	3.52	0.207
Arginine	6.76	7.14	7.11	7.82	6.88	6.67	0.647
Alanine	4.22	3.95	3.89	3.99	3.98	3.89	0.237
Proline	5.22	5.88	5.67	4.99	4.86	4.01	0.234
Total NEAA	47.9	50.28	49.88	51.57	50.88	47.88	3.459
EAA:NEAA	1.10	1.07	1.00	0.99	0.97	1.07	0.201

SEM: standard error for the mean.

lower values for bactrian muscles were reported by Urbisinov (1992). Similarly, in dromedary muscles, the glutamic and aspartic acids, the major non-essential amino acids in camel meat, ranged from 15.95 to 18.60% and from 9.30 to 10.80% of protein, respectively (Dawood and Alkanhal, 1995; Elgasim and Alkanhal, 1992; Al-shabib and Abu-Tarboush, 2004; Kadim *et al,* 2011). In general, camel meat may be a better source of non-essential amino acids than beef, lamb and goat meats (Kadim *et al,* 2011; Dawood and Alkanhal, 1995; Elgasim and Alkanhal, 1992; Al-Shabib and Abu-Tarboush, 2004). Although, Elgasim and Alkanhal (1992) found low alanine levels in camel meat compared to other red meats. Dawood and Alkanhal (1995); Al-Shabib and Abu-Tarboush (2004) and Kadim *et al* (2011) found similar concentration of alanine in the dromedary muscles and other red meats. Finally, a particularly high essential amino acid/non-essential amino acid ratio was also recorded with SM and LT muscles having the highest ratios, while the BF muscle had the lowest ratios (Table 5).

Effect of type of muscle on Vitamins

Water and fat soluble vitamins concentration (mg/100 g fresh meat) in bactrian camel IS, TB, LT, ST, SM and BF muscles are presented in table 6. The water-soluble vitamins in meat varied in quantities from a few micrograms to several milligrams per 100 g. There were no significant differences in thiamine (B1) concentration between individual muscles, ranging from 0.08 mg/100 g determined in bactrian camel TB, LT and BF muscles to 0.09 mg/100g determined in both IS, ST and SM muscles. In contrast, Lombardi-Boccia *et al* (2005) showed significant variation in thiamine concentration among the cuts of the same species. In beef, there were significant differences (P<0:05) in thiamine content between the loin muscles (0.2 mg/100g) and leg muscles (0.8 mg/100g) (Lombardi-Boccia *et al,* 2005). The latter authors found that chicken and turkey's breast had low thiamine concentration ranging between 0.2 and 0.4 mg/100. The thiamine concentration in bactrian camel muscles (0.09 mg/100g) was higher than beef (0.5 mg/100g),

lamb (0.06 mg/100g), rabbit meats (0.05 mg/100g), chicken (0.04 mg/100g) and Turkey (0.02 mg/100g) and lower than veal (0.11 mg/100g), horse (0.18 mg/100g), ostrich (0.16 mg/100g) and similar to pork (0.8 mg/100g) (Lombardi-Boccia *et al* (2005). Vitamin B6 is related to protein content of the diet. It is also necessary for the formation of haemoglobin (Henderson *et al,* 2003). The vitamin B_6 concentration in the present study ranged from 0.61 to 0.67 mg/100g (Table 6). The current values are higher than reported by Moss *et al* (1983), 0.35 to 0.49 mg/100 g for pork meat, turkey meat (0.42 mg/100g), chicken meat (0.53 mg/100g) and fish (0.34 mg/100g) (Sauberlich *et al,* 1982). The daily recommended dietary allowance for vitamin B_6 is 1.6 mg for women and 2.0 mg for men (Food and Nutrition Board, 1989). Meats, along with dairy products and eggs are the major providers of vitamin B_6. An average serving of bactrian camel meat (200 g) provides 80% of the RDA for vitamin B_6 for the young adult male. Pantothenic acid plays a key role in energy metabolism. The variations in pantothenic acid (B_5) between the selected muscles were not high enough to reach significant level. The TB muscle had the highest B_5 level (0.89 mg/100g) and the SM muscle (0.82 mg/100g) had the lowest. Vitamin B_{12} is required by rapidly dividing cells such as those in the bone marrow which form blood cells (Henderson *et al,* 2003). Small variations were found between bactrian camel muscles for vitamin B_{12} concentrations, with the range value from 4.53 to 4.98 µg/100 g. Meat and meat products serve as the main source of vitamin B_{12} in the food supply and about 35% of vitamin B_{12} intake comes from meat and meat products (Henderson *et al,* 2003). According to Karmas (1988), meat contributes in general 77% (7.5 µg of the 9.7 µg) of the vitamin B_{12} in the diet. The RDA for vitamin B_{12} is 2.0 µg for men and women. Fifty gram of bactrian camel meat will contain 2.38g/100 g vitamin B_{12}, which represent 118% of the RDA for vitamin B_{12}. The average bactrian camel meat contained 4.75µg/100 g vitamin B_{12}, which provides ample amounts of this vitamin. The vitamin B_{12} concentration (0.75–0.92 mg/100 g) in pork reported by Moss *et al* (1983) was higher than the value found in the bactrian camel meat. The bactrian camel meat had higher vitamin B_{12} than sheep (0.25 mg/100g) and veal meats (0.18 mg/100g) (Ono *et al,* 1984; Ono *et al,* 1986) The SM muscle (4.98 µg/100 g) had the highest vitamin B_{12} content and the BF muscle (4.53 µg/100 g) among the muscles studied. Riboflavin is necessary for normal growth and helps maintain the integrity of mucous membranes, skin, eyes and nervous system (Henderson *et al,* 2003). Riboflavin is found in red meat and 15% of the average daily intake in human is derived from meat and meat products. Riboflavin content varied between bactrian camel muscles from 0.20 to 0.29 mg/100g) with BF muscle had the highest value (0.29 mg/100g) while the ST (0.20 mg/100g) the lowest value (Table 5). Similarly, Lombardi-Boccia *et al* (2005) reported that among beef meat cuts, riboflavin concentration varied from 0.09 to 0.17 mg/100 g, with fillet showing the highest concentration. Beef (0.13 mg/100g), veal (0.08 mg/100g), lamb (0.195 mg/100g), ostrich (0.10 mg/100g), pork (0.13 mg/100g), chicken (0.03 mg/100g), turkey (0.06 mg/100g) and rabbit (0.11 mg/100g) meats showed a riboflavin concentration lower than in bactrian camel muscles (Lombardi-Boccia *et al,* 2005; Purchas *et al,* 2014). Horse meat had similar concentration of riboflavin (0.20 mg/100 g) among all the species (Lombardi-Boccia *et al,* 2005).

Table 6. Effect of type of muscle on water and fat soluble vitamins levels of *Infraspinatus, Triceps brachii, Longissimus thoracis, Semitendinosus, Semimembranosus, Biceps femoris* muscles of bactrian camel.

Vitamin	Muscle						
	IS	TB	LT	ST	SM	BF	SEM
Water soluble vitamins							
Thiamine (B_1) (mg/100g)	0.09	0.08	0.08	0.09	0.09	0.08	0.009
Pyridoxine (B_6) (mg/100g)	0.64	0.62	0.66	0.65	0.61	0.67	0.081
Pantothenic acid (B_5) (mg/100g)	0.88	0.89	0.86	0.87	0.82	0.84	0.135
Cyanocobalamin (B_{12}) (µg/100g)	4.64	4.74	4.83	4.86	4.98	4.53	0.033
Riboflavin (B_2) (mg/100g)	0.23	0.21	0.22	0.20	0.26	0.29	0.011
Fat soluble vitamins							
Retinol (A) (µg/100g)	10.5	10.3	11.2	9.99	10.1	9.97	0.153
Alpha-Tocopherol (E) (mg/100g)	0.85	0.89	0.92	0.82	0.86	0.87	0.032

SEM: standard error for the mean.

Vitamin A is present in small amounts in meat and it depends in the amount of intramuscular fat of the meat. The camel meat has a low intramuscular fat (Kadim *et al,* 2008). Therefore, vitamin A will be low compared to other species of red meat animals with high intramuscular fat content. In the present study, vitamin A content (9.97 -10.5 µg/100g) was very low and similar between the individual muscles (Table 6). Vitamin E is a powerful antioxidant and has been shown to improve the colour stability and shelf-life of red meat (Pearce and Jacob, 2004). Although, vitamin E content was similar between the bactrian camel muscles, the LT muscle (0.92 mg/100g) and TB muscle (0.89 mg/100 g) among the highest, while ST muscle (0.82 mg/100g) among the lowest muscles. The small variations between muscles for vitamins studied may be due to small differences in muscle fiber types and intramuscular fat content between muscles studied. bactrian camel meat is reputed to be healthier than other red meats such as beef or lamb. It is leaner and a good source of protein and vitamins.

In persent study, a comparison of the nutrient content of six muscles from bactrian camels revealed that camel meat is rich in a wide range of essential nutrients for human. Type of muscle had a significant effect on the concentrations of several nutrients. Small differences in fatty acid composition and cholesterol were detected between muscles. The amino acid composition and vitamin content in muscles were similar and can match with recommended requirements for human nutrition. bactrian camel meat can compete well with other red meats for the fatty acid profile as it contains high levels of PUFAs with a high UFA:SFA ratio. In general, the bactrian camel meat would be a healthy alternative to traditional red meat and can be competitively marketed alongside meat from cattle, deer, sheep and goats.

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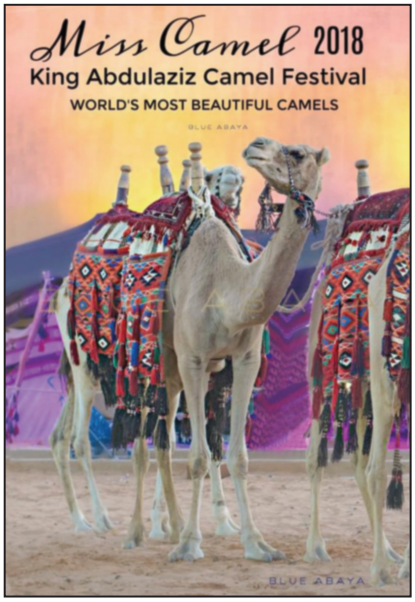
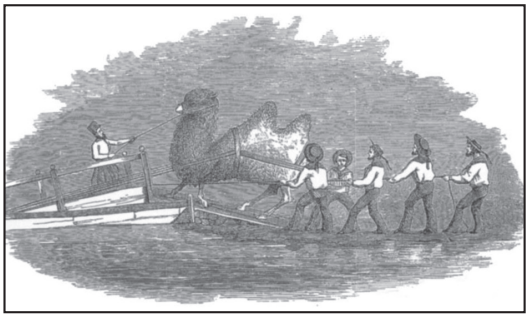
12 CAMELS DISQUALIFIED FROM SAUDI BEAUTY CONTEST IN 'BOTOX' ROW



Twelve camels were disqualified from Saudi Arabia's annual camel beauty contest after receiving botulinum toxin injections to make their pouts look more alluring. Saudi authorities have raised the profile of the King Abdulaziz camel festival by relocating it from the desert to the outskirts of the capital, Riyadh. This year's event has been been mired in scandal after the lure of 20m Saudi riyals (£3.7m) in prize money for each category tempted some owners to cheat. The key attributes in camel beauty are considered to be delicate ears and big nose. But there are strict rules against the use of drugs in the lips, or shaved or clipped body parts. This year, a dozen camels were banned after a vet was caught performing plastic surgery on them. Camels were also given Botox-type injections at his clinic, according to Saudi media. "They use Botox for the lips, the nose, the upper lips, the lower lips and even the jaw," Ali al-Mazrouei, the son of an Emirati camel breeder, told the UAE daily ."It makes the head more inflated so when the camel comes it's like, 'Oh, look at how big that head is. It has big lips, a big nose.'" After the ban was imposed, the chief judge of the show, Fawzan al-Madi, told Reuters: "The camel is a symbol of Saudi Arabia. We used to preserve it out of necessity, now we preserve it as a pastime." The month-long festival is the biggest in the Gulf and involves up 30,000 camels.

UNITED STATES CAMEL CORPS

In 1836, Major George H. Crosman, United States Army, who was convinced from his experiences in the Indian wars in Florida that camels would be useful as beasts of burden, encouraged the War Department to use camels for transportation. In 1848 or earlier, Major Henry C. Wayne conducted a more detailed study and recommended importation of camels to the War Department. United States Camel Corps was active in 1856–1866 at USA and was a branch of US Army. Its role was experimental and post was Camp Verde, Texas. Its first commander was Major Henry C. Wayne. Newly appointed as Secretary of War by President Franklin Pierce, Davis found the Army needed to improve transportation in the southwestern US, which he and most observers thought a great desert. In his annual report for 1854, Davis wrote, "I again invite attention to the advantages to be anticipated from the use of camels and dromedaries for military and other purposes...."[2]:10 On March 3, 1855, the US Congress appropriated $30,000 for the project.[1]:393–394.



The United States Camel Corps was a mid-19th century experiment by the United States Army in using camels as pack animals in the Southwestern United States. While the camels proved to be hardy and well suited to travel through the region, the Army declined to adopt them for military use. The Civil War interfered with the experiment and it was eventually abandoned; the animals were sold at auction.

(Source: Wikipedia, the free encyclopedia)