



Effect of breed on the quality attributes of camel meat

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ABSTRACT

This study was carried out to differentiate between camel breeds with respect to their chemical composition and meat quality characteristics. Four breeds were selected: Magahem, Wodoh, Shoal, and Sofor. The animals' ages and final weight were approximately 12 months and 281.3±9.32 kg, respectively. To identify the differences between these breeds, we collected 6 *longissimus dorsi* (LD) and 6 *Biceps femoris* (BF) muscles from the animals. Meat samples were taken from the LD for chemical composition analysis, and meat quality parameters were characterized for both types of muscles. Assessments were made of the following parameters: myofibril fragmentation index (MFI) score, sarcomere length (SL), fiber area (FA), slice shear force (SSF), pH, loss of volume through cooking, cooking time, and color. The breed groups exhibited significant differences in their fat content as well as differences in SSF values for the LD: Shoa>Wodoh>Sofor>Magahem. The 4 breeds also showed significant differences in LD MFI values. The results indicate that there are significant differences between the breed groups and their muscles with respect to the composition and quality of their meat.

Key words: Breed, Camel, Meat quality

The estimated population of dromedary camels (*Camelus dromedarius*) in Saudi Arabia is 869000 head (AOAD 2009). Dawood and Alkanhal (1995) and Kadim *et al.* (2006) investigated the nutrient composition and quality of camel meat as a function of age. El-Faer *et al.* (1991) and Elgasim and Alkanhal (1992) investigated the proximate composition and mineral content of camel meat, comparing various carcass cuts and against other sources of white and red meat, respectively. Yousif and Babiker (1989), Babiker and Yousif (1990), and Dawood (1995) focused on chemical composition, carcass measurements, and quality of camel meat.

Differences between camel breeds in milk production, body measurements, and other parameters other than meat are described in the literature (Abu-Lehia 1989, Elamin and Wilcox 1992, Mehaia *et al.* 1995, Al-Hazmi *et al.* 1994, Faye *et al.* 2001, Al-Busadah 2007). However, very few studies have investigated the differences between camel breeds with respect to the chemical composition and quality attributes of their meat. Hence, the objective of this study was to determine the effect of breed on the camel meat quality.

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MATERIALS AND METHODS

Male camels (24), 6- month-old, weighing 133.83±2.83 kg 6 per breed (Magahem, Wodoh, Shoal, and Sofor) were used in this study.. They were fed intensive rations consisting of alfalfa hay and a commercial concentrate mixture for 204 days and had free access to drinking water. The 4 groups were fed the same iso-caloric and iso-nitrogenous ration. Camels were weighed every 2 weeks. Feeding data and results of growth rate and feed intake were used by other research group.

Meat quality traits: Camels were slaughtered after 204 days, in a local slaughterhouse. *Longissimus dorsi* (LD) from the 9th to 12th vertebrate and *Biceps femoris* (BF) from the left side were collected and transferred to University Laboratory. The muscles were stored at 2°C for 24 h. At 24 h after slaughter, 2.54-cm-thick steaks from the LD and BF muscles were obtained, vacuum packaged and stored at –20°C for determination of slice shear force (SSF). The rest of the LD and BF muscles were used for the other meat quality analysis.

Chemical composition: The LD muscle was used to estimate moisture, protein, fat, and ash according to a protocol described by the AOAC (2000).

Slice shear force: The frozen steaks were thawed for 24 h at 4°C and then placed in a commercial grilling oven and

cooked to an internal temperature of 70°C. Internal temperatures were monitored by inserting a thermocouple probe into the geometric center of each steak. The cooking time was recorded for each sample, and the steaks were weighed before and after cooking to determine loss through cooking. The SSF for the LD and BF samples was assessed as described by Shackelford *et al.* (1999 and 2010, respectively).

Myofibril fragmentation index: The myofibril fragmentation index (MFI) of the LD and BF muscles from the four breeds was determined using the procedures described by Culler *et al.* (1978). Briefly, 4 g of scissor-minced muscle was homogenized in a blender with 40 ml cold (2°C) MFI buffer. After several washes, the absorbance of the resultant 0.5 mg/ml solution was evaluated at 540 nm. The MFI of each sample was determined by multiplying the absorbance at 540 nm by 200.

Sarcomere length: The sarcomere length (SL) of the LD and BF samples from the four breeds was determined by removing three longitudinal samples (3 cm × 3 cm × 2 cm) and storing them in a 5% glutaraldehyde solution for 4 h at 4°C. Then, laser diffraction was used to measure the SL of each sample according to the method described by Cross *et al.* (1981).

Fiber area cryosectioning and staining: The fiber areas (FAs) of the LD and BF muscles were evaluated. Core samples obtained from the left LD between the 12th and 13th ribs were removed and cut into 3 × 1 cm pieces and immediately immersed in liquid nitrogen, vacuum packaged and stored at -20°C. Next, the muscle samples were embedded in a tissue-freezing medium (Jung), and a cryostat was used to cut the samples into 7-μm-thick sections. The sections were (H&E) stained according to the method of Bancroft and Cook (1984). The stained sections were viewed under a Dm-3000 light microscope at a magnification of 40×.

pH and color: pH was determined after 24 h using the pH meter. Color values (L*, a*, and b*) were measured using a colorimeter.

The obtained data regarding the four camel breeds were analyzed as one way analysis of variance using SPSS package (2005). Differences between means were tested using the least significant difference (LSD).

RESULTS AND DISCUSSION

Chemical composition: The chemical composition of the camels' meat, grouped by breed, is shown in Table 1. The meat exhibited similar moisture, protein, and ash content ($P>0.05$) but differed in fat content ($P<0.05$). The Wodoh meat had the highest fat content, to an extent that was statistically significant as compared with the fat content of Shoal and Sofor meat but not with Magahem meat. The differences in fat content between the Magahem, Shoal, and Sofor breeds were not significant ($P<0.05$). The amount of detected fat in this study is comparable to other findings

Table 1. Chemical composition of *Longissimus dorsi* (LD) muscle of Magahem, Wodoh, Shoal and Sofor camel breeds

Parameter	Breed				SE	P
	Magahem	Wodoh	Shoal	Sofor		
Moisture%	73.01	72.87	72.99	73.35	0.16	0.76
Protein%	20.97	21.59	21.63	21.31	0.25	0.80
Fat%	4.14 ^{ab}	4.82 ^a	3.52 ^b	3.76 ^b	0.17	0.03
Ash%	1.32	1.42	1.40	1.45	0.03	0.38

a, b, c Means in the same row with different superscripts are significantly different ($P<0.05$).

(Dawood and Alkanhal 1995, Kadim *et al.* 2006). The variation regarding fat content could be attributed to breed difference, which is consistent with the conclusion reported by Keane and Moloney (2008), however, the fat values reported in our study are slightly higher than those cited by El-Faer *et al.* (1991) and Elgasim and Alkanhal (1992). A larger amount of dry matter in Wodoh camels was associated with higher fat content, which is in accordance with the findings of Van Koeveing *et al.* (1995) and Bureš *et al.* (2006). The absence of a breed effect on muscle protein agrees with the findings of Keane *et al.* (1991).

To determine the influence of breed on the chemical composition and quality of camel meat, LD and BF samples were selected from 4 camel breeds that are common in Saudi Arabia. Consistent with previous reports, the moisture and protein content of the meat was similar, but we found differences in fat content. Dawood and Alkanhal (1995) reported averages of 71.56%, 20.39%, and 7.19% for moisture, protein, and fat, respectively, in meat from camels that were similar in age to those used in our study. Similarly, Kadim *et al.* (2006) reported averages of 71.7%, 22.7%, and 4.4% for moisture, protein, and fat, respectively, in meat from camels in the same age range as the breed groups in our study. In another study, Kadim *et al.* (2008) found that Arabian camel meat contained 70.8% moisture, 21.6% protein, and 2.8% fat. Al-Sheddy *et al.* (1999) determined that camel meat has moisture, protein, and fat composition of 75.19%, 21.34, and 2.26%, respectively. Dyoub and Hamed (2009) reported that meat from the single-humped Syrian camel consisted of, on average, 77.49% moisture, 19.61% protein, and 1.04% fat for animals ranging in age from 1.5 to 6 years. Gheisar *et al.* (2009) found that meat from single-humped Iranian camels contained 67.33%±2.08 moisture, 21.66%±1.18 protein, and 1.48%±0.13 fat, and the Wodoh breed had the highest fat content ($P<0.05$).

Slice shear force, myofibril fragmentation index, sarcomere length, and fiber area: The SSF, MFI, SL, and FA values for the LD and BF samples are reported in Table 2. There was a large variation in LD SSF, which ranged from 6.45 kg in the Magahem to 14.32 kg in the Shoal breed. The SSF ranking for LD was Shoal>Wodoh>Sofor>Magahem. The BF SSF ranged from 19.44 kg for the Wodoh breed to

23.25 kg for the Shoal breed. To determine the source of the observed differences in SSF, we measured the MFI, pH, and SL. In general, breeds exhibited similar MFI, pH, and SL values for both LD and BF. Cooking data and color components are summarized in Table 3. Volume lost through cooking and cooking time were generally the same for both cuts from all 4 breeds. However, there was a significant difference between the Shoal and Wodoh breeds in terms of BF cooking-loss percentage, whereas Magahem and Sofor did not differ from these 2 breeds. The ranking for the BF cooking-loss percentage was Shoal>Sofor>Magahem>Wodoh. To assess color variations, we determined Hunter L*, a*, and b* values. With the exception of the a* value for the Sofor LD, no statistically significant differences were observed.

The 4 breed groups were significantly different in terms of SSF for both LD and BF muscles (Table 2). The Magahem and Wodoh breeds exhibited the lowest SSF values for LD and BF muscles, respectively, and the Shoal and Magahem breeds obtained the highest values, respectively. The Magahem and Wodoh breeds differed significantly ($P<0.05$) in SSF for both muscles, whereas the Shoal and Sofor breeds differed only in terms of the LD muscle ($P<0.05$). By contrast, the Wodoh and Shoal breeds also differed ($P<0.05$) in terms of SSF but only for the BF muscle. Generally, the SSF values recorded in this study for both muscles were higher in comparison with previous studies, except for that of the LD muscle of the Magahem breed, in which the obtained value of 6.45 was comparable to those obtained by others (Kadim *et al.* 2006 and Al-Owaimer 2002).

The MFI scores, SLs, and FAs of the LD and BF muscles of the camel breeds are listed in Table 2. The breeds differed significantly ($P<0.05$) in terms of MFI for LD muscles but

Table 2. Effect of camel breed on slice shear force (SSF), myofibril fragmentation index (MFI), sarcomere length (SL) and fiber area (FA) of *Longissimus dorsi* (LD) and *Biceps femoris* (BF) muscles

Parameter	Breed				SE	P
	Magahem	Wodoh	Shoal	Sofor		
SSF (kg/cm ²)						
LD	6.45 ^c	13.73 ^a	14.32 ^a	10.40 ^b	0.70	<0.0001
BF	23.32 ^a	19.44 ^b	23.25 ^a	22.77 ^a	0.46	0.001
MFI%						
LD	71.63 ^a	66.15 ^b	65.44 ^b	67.03 ^b	0.61	<0.0001
BF	62.42	60.92	63.03	61.17	0.50	0.40
SL (μm)						
LD	1.69	1.68	1.64	1.65	0.03	0.95
BF	1.68	1.66	1.69	1.67	0.03	0.97
FA (μm ²)						
LD	4624.38	4947.07	5031.57	4304.27	151.34	0.32
BF	4067.68	4169.98	4384.30	4426.75	139.54	0.79

a, b, c Means in the same row with different superscripts are significantly different ($P<0.05$).

not for BF muscles. The Magahem breed exhibited the highest ($P<0.05$) MFI as compared with the other breed groups, whereas the Wodoh, Shoal, and Sofor breeds did not differ significantly ($P<0.05$). The MFI determined in this study was higher than that found by Al-Owaimer (2002), this difference could be due to differences in animals' ages between the two studies. The slight differences between these values and those found by Kadim *et al.* (2006) could be due to breed differences. The four breeds also did not differ significantly in terms of SL in both LD and BF muscles although the Magahem and Sofor breeds had the highest SL values for LD and BF muscles, respectively. The higher LD muscle MFI values of the Magahem and Sofor breeds were consistent with their observed longer SLs. The SLs of the breed groups examined in our study were shorter than those noted by Al-Owaimer (2002) and Kadim *et al.* (2006) for camels in the same age range. The four camel breeds in our study did not differ in their FAs for both LD and BF muscles. The FAs obtained were smaller than those reported by Kadim *et al.* (2009) for dromedary camels.

pH₂₄, cooking loss, cooking time, and color: The impact of camel breed on pH₂₄, cooking loss, cooking time, and color of LD and BF muscles is summarized in Table 3. The breed groups did not statistically differ in terms of pH₂₄ for both muscles. The treatment groups did not differ in terms of cooking loss for the LD muscle and cooking time for both muscles; however, they did differ significantly in terms of cooking loss for BF muscle. BF muscle showed greater loss

Table 3. Effect of camel breed on pH₂₄, cooking loss, cooking time and color of *Longissimus dorsi* (LD) and *Biceps femoris* (BF) muscles

Parameter	Breed				SE	P
	Magahem	Wodoh	Shoal	Sofor		
pH ₂₄						
LD	5.76	5.87	5.91	6.07	0.08	0.65
BF	5.90	5.90	5.82	6.03	0.05	0.54
Cooking Loss%						
LD	23.68	21.91	22.87	22.39	0.44	0.55
BF	28.25 ^{ab}	26.00 ^b	31.24 ^a	28.70 ^{ab}	0.63	0.02
Cooking Time (min)						
LD	5.83	5.83	5.83	6.00	0.07	0.80
BF	6.67	6.67	6.00	6.67	0.18	0.49
Color						
L*						
LD	31.55	33.37	31.57	31.18	0.49	0.41
BF	29.98	28.07	31.20	29.71	0.42	0.06
a*						
LD	11.81 ^b	12.98 ^{ab}	12.78 ^b	15.02 ^a	0.40	0.02
BF	13.34	13.60	13.43	13.10	0.29	0.95
b*						
LD	4.03	4.74	4.43	4.85	0.14	0.16
BF	4.07	3.91	4.26	3.91	0.18	0.91

a, b, c Means in the same row with different superscripts are significantly different ($P<0.05$).

during cooking, with an associated longer cooking time that may have led to this result. The color of the BF muscle did not differ significantly between the breeds, whereas the a^* component appeared to be significantly different for the LD muscle. The other color components of the LD muscle were not significantly different between the breeds. A higher redness (a^*) color component in the LD muscle was associated with a lower lightness (L^*), which might be due to an increase in myoglobin content. Generally, the LD muscle was lighter than the BF muscle because of the higher ($P < 0.05$) value of redness in the latter. The observed pH_{24} values of the breed groups were within the range presented by Kadim *et al.* (2006) for camel breeds. The Sofor breed was observed to maintain a higher pH value ($P < 0.05$) than other breed groups, which could be due to a lower rate of lactic acid development in the muscles because of glycogen depletion, which in turn is a result of pre-slaughter handling.

This study indicated that the Magahem, Wodoh, Shoal, and Sofor camel breeds are very similar with respect to their meat chemical composition and quality. However, meat from the *Longissimus dorsi* muscle of Magahem breed is more tender compared to the other 3 breeds. We recommend that further studies be conducted to identify additional differences in the constituents and quality attributes of meat from these camel breeds as fatty acids content and amino acids.

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