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IMPROVING MATURE CAMEL-MEAT QUALITY CHARACTERISTICS WITH CALCIUM CHLORIDE INJECTION

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ABSTRACT

This study was carried out to enhance mature camel meat tenderness with calcium chloride injection. Eight Somali male camels were used in this study. Their average weight and age were 500 kg and 5-6 years. The Longissimus dorsi muscles of each carcass were assigned randomly to either a control where no injection applied or 250 mM food-grade calcium chloride ($CaCl_2$) injection at 5% (wt/wt). Values of colour components were not significantly ($P > 0.05$) affected by the treatments, although, slight increase in redness (a*) appeared in treated groups accompanied by observed decrease in lightness (L*). Water-holding capacity, shear force and myofibril fragmentation index showed significant differences between the treatments. Treated groups showed less shear value and higher myofibril fragmentation index indicating an improvement in tenderness compared to control group. It also was observed that the myofibril fragmentation index was highly ($P < 0.01$) correlated with drip loss and negatively ($P < 0.01$) correlated with water-holding capacity and shear force. This study came to a conclusion that using calcium chloride injection for Somali camel meat results in improved meat tenderness and enhanced quality traits.

Key words: Calcium chloride, injection, meat, quality traits, somali camel

The self sufficient ratio (SSR) of red meat for Saudi Arabia is about 41.31% (AOAD, 2010). This country depends on imports of many meat-producing animals to fill the gap between demand and supply. Somali camels are one of the breeds introduced into Saudi markets. But these animals are usually old and suffering from the method and distance of transportation, which affect the quality of their meat. On the other hand, local Saudi camels are usually slaughtered at a younger age (one year or less) comparing to imported breeds. It is well recognised that tenderness has long been known as one of the basic meat quality attributes that determined its acceptability (Lawrie, 1979; Jeremiah, 1982; Jerez *et al,* 2003). Many factors influence meat tenderness. The most important ones are genetics, age of the animal, location of the cut on the carcass, processing, method of cooking, and degree of doneness (Epley, 1992). Many post-harvest practices are sometimes implemented to improve tenderness of meat. These may include electrical stimulation, aging, mechanical tenderisation, marination or injection with different substances and programmes of chilling. Usually tenderness enhancement practices are used for larger animals such as cattle and camels rather than small ones. Considerable works (El-Dashlouty *et al,* 1977; El-Samahy and Shehata, 1978; Berge *et al,* 2001; Aalhus, 2002; Aalhus *et al,* 2002; Burke and Monahan, 2003; Dikeman *et al,* 2003; Carr *et al,* 2004; Baublits *et al,* 2005; Bratcher *et al,* 2005) were performed regarding improving meat quality traits of cattle. On the contrary, limited studies were carried out aiming to improve quality characteristics of camel meat (Al-Sheddy and Al-Owaimer, 2000; Habiba, 2006 and Sami *et al,* 2011). Hence, the objective of this study was to enhance the tenderness and acceptability of Somali camel meat with calcium chloride injection.

Materials and Methods

Experimental animals and sampling

Eight Somali male camels were used in this study. Their average weight and age were 500 kg and 5-6 years. Immediately after slaughter, rib eye (*Longissimus dorsi*) muscle was removed from the carcass of the animal on both sides. After 24 hours chill, the right muscle of each carcass was used as a control where no injection applied, while the left one was injected with 250 mM food-grade calcium chloride ($CaCl_2$) at 5% (wt/wt). The injection was

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performed using a 50 ml syringe with a needle inserted into the muscle at various locations to ensure even distribution of the solution. Distilled water at 22°C was used to prepare the calcium chloride solution. After injection, the muscles were allowed to set for five minutes, and then weighed to check the final percentage of injection. The muscles were then cut into chops, vacuum-packaged, labelled and stored at 2°C for either 1, 3, or 7 days. Thereafter, the chops were frozen at - 21°C following the appropriate aging time.

Measurements

The colour values of CIELAB Colour System (1976), L* (lightness) a* (redness) and b* (yellowness), were determined using a Chroma meter (Konica Minolta, CR-400-Japan). Hydrogen ion concentration (pH) was measured directly in the muscle using a microprocessor pH-Meter (Model PH 211, Hanna Instruments). Two readings were taken at the beginning for the control group and after the end of each aging period for the treatment groups. Then, the mean value was calculated for each carcass. The frozen chops were thawed overnight at 4°C. Then, they were placed in a commercial indoor countertop grill (Kalorik, Model: GR 28215) and cooked to an internal temperature of 70°C. The temperature was monitored by inserting a thermocouple thermometer probe (Ecoscan Temp JKT, Eutech Instruments) into the geometric centre of the muscle. The muscles were weighed before and after cooking to determine cooking loss as the difference between the initial and final weights. The cooked samples used for determining cooking loss were used to evaluate shear force according to Wheeler *et al* (2005). They were cooled to room temperature (21°C), then five 1.27 cm in diameter round cores was removed from each muscle sample parallel to the longitudinal orientation of the muscle fibres. Cores were obtained using a handheld coring device. Shear force was determined as the maximum force (Kg) perpendicular to the fibres using Texture Analyser (TA-HD-Stable Micro Systems, England) equipped with a Warner-Bratzler attachment. The crosshead speed was set at 200 mm/min. Drip loss was determined as a percentage of the purge weight over sample weight. Myofibril fragmentation index (MFI) was done as described by Culler *et al* (1978), while the sarcomere length was performed as described by Cross *et al* (1981). Water-holding capacity (WHC) was determined by centrifugation following the method described by Honikel (1998).

Statistical analyses

Statistical analyses were performed using SPSS program package (v 16.0). Mean differences were separated using Duncan test.

Results

Meat quality characteristics obtained in this study are presented in Table 1. All the figures fell within the normal range of quality traits for camel meat.

Table 1. Minimum, maximum, mean, and standard deviation for meat quality traits of Somali camel *L. dorsi* muscle.

Parameter	Minimum	Maximum	Mean	SD
pH	5.04	6.13	5.49	0.22
Drip Loss%	2.47	11.62	6.59	2.61
WHC	1.03	1.20	1.09	0.04
Cooking Loss%	26.23	42.38	32.34	3.60
Shear Force (kg)	1.86	7.09	3.49	1.06
MFI	27.80	95.90	66.28	19.14
Sarcomere Length (µm)	1.46	2.28	1.75	0.20
Colour:				
L*	32.20	49.72	42.44	4.19
a*	10.56	23.13	17.02	3.24
b*	4.78	15.94	9.32	2.58

Table 2 shows pH, drip loss and colour components of *L. dorsi* muscles obtained from the experimental groups. The experimental groups showed insignificant differences between them in pH and colour components. On the other hand, day 3 and day 7 groups revealed a significant ($P < 0.05$) difference between them. Day 7 group tended to loose more moisture (7.98%) than day 3 (5.20%).

Table 2. pH, Drip loss% and colour values of Somali camel *L. dorsi* muscle treated with calcium chloride.

Parameter	Treatment				S.E	P-value
	Control	Day 1	Day 3	Day 7		
pH	5.63	5.64	5.64	5.66	0.14	0.15
Drip Loss %	ND	ND	5.20[a]	7.98[b]	0.65	0.03*
Colour:						
L*	42.70	44.56	41.34	41.16	0.74	0.35
a*	15.80	16.99	17.32	17.98	0.57	0.61
b*	8.19	10.50	8.91	9.70	0.46	0.32

ND Not defined (Control and day 1 group did not undergo aging)

Water-holding capacity, cooking loss and fibre characteristics data are presented in Table 3. Treated groups showed no significant differences for

cooking loss and sarcomere length. While they were statistically significant (P < 0.05) for water-holding capacity, shear force and myofibril fragmentation index. The control group performed the highest (34.41%) cooking loss compared to the treated groups indicating an effect over them as a result of the application of calcium chloride. The highest value of water-holding capacity was obtained by the control group indicating an inferior capacity for maintaining water compared to the other treated groups. This result is compatible with that reported in the control group for cooking loss. Day 7 group showed the lowest shear force value when compared to the control group and other treated groups. Whereas the control group showed the highest value of shear force. The same trend was true for MFI where the control group attained the lowest MFI and the 7 day group attained the highest MFI value. This could be an indication of the improvement of meat quality as a result of injection with calcium chloride.

Table 3. Water-holding capacity, cooking loss and fibre characteristics of Somali camel *L. dorsi* muscle treated with calcium chloride.

Parameter	Treatment				S.E	P-value
	Control	Day 1	Day 3	Day 7		
WHC	1.14^{b}	1.06^{a}	1.08^{a}	1.08^{a}	0.01	< 0.001
Cooking Loss%	34.41	31.76	31.74	31.44	0.64	0.32
Shear Force (kg)	4.16^{b}	3.50^{ab}	3.29^{ab}	3.01^{a}	0.19	0.04
Sarcomere Length (µm)	1.76	1.74	1.78	1.74	0.04	0.98
MFI	42.58^{a}	68.64^{b}	70.34^{b}	83.58^{c}	3.38	< 0.001

Table 4 shows Pearson correlation coefficients (r) of quality traits of treated Somali camel *L. dorsi* muscles. Drip loss was found to be highly correlated positively with MFI. This was also true for WHC with shear force and MFI, but negatively with the latter. The shear force was also found to be negatively correlated with MFI.

Table 4. Pearson correlation coefficients (r) for meat quality traits of Somali camel *L. dorsi* muscle treated with calcium chloride

	WHC	Cooking Loss	Shear Force	MFI	Sar. Length
Drip Loss	- 0.14	- 0.11	- 0.14	0.77**	0.20
WHC		- 0.02	0.46**	- 0.50**	0.04
Cooking Loss			0.33	- 0.28	- 0.15
Shear Force				- 0.48**	0.02
MFI					0.05

** Correlation is significant at the 0.01 level.

Discussion

Colour values and *pH* did not show any differences between control and treatment groups or within aging times for calcium chloride treatment, whereas drip loss was significant by (P <0.05) different between the treatment groups. It is also observed that drip loss was increased significantly as aging period increased. This result was in line with that reported by Kerth *et al* (1995) who found a significant increase in purge percentage between 7 and 14 days of aging of treated meat samples and that of Thomson and Dobbie (1997) who stated that the calcium chloride treatment increased weight loss during storage. In this study, the treatment groups showed a slight and gradual increase (P > 0.05) in redness value (a*) compared to control group. On the contrary, lightness (L*) was slightly decreased (P > 0.05) with aging. Again, the obtained results in this study were same as that reported by Jerez *et al* (2003) who stated that treatment with calcium chloride and other glycolytic inhibitors did not affect the meat colour and that of Wheeler *et al* (1993) who showed that the lean colour was not affected by calcium chloride injection, but tended to be slightly darker. It is also concluded by Diles *et al* (1994) that calcium chloride had no significant effect on measures of colour, however, colorimeter L* was reduced.

Water-holding capacity, shear force and myofibril fragmentation index (MFI) showed significant differences between the treatments. Water-holding capacity was significantly (P < 0.001) improved as a result of the treatment. This finding was the same as that obtained by Sultana *et al* (2008) and Jerez *et al* (2003). On the other hand, cooking loss and sarcomere length did not differ significantly (P > 0.05) between the treatment groups. Although, cooking loss was improved in the groups that were injected with calcium chloride. The exact conclusions were stated by Klinhom *et al* (2009), Sultana *et al* (2008) and Jerez *et al* (2003), but disagreed with that of Morgan *et al* (1991) who reported no effect on cooking loss due to calcium chloride injection. Shear force was significantly decreased when comparing treated groups with the control, indicating an improvement of tenderness as a result of the application of calcium chloride injection. This result was in line with that reported by Lansdell *et al* (1995), Diles *et al* (1994) and Wheeler *et al* (1993). Boleman *et al* (1995) also noticed that shear force values were significantly higher in control samples compared with injected samples. The highest shear force value (4.16 kg) of the control group matched with the lowest MFI value (42.58)

of the same group. This trend was also reported by Chambaz *et al* (2003). Myofibril fragmentation index revealed the same pattern as shear force and was statistically significant ($P < 0.001$). It increased as a result of the treatment and aging.

The Myofibril fragmentation index was found to be highly ($P < 0.01$) correlated with drip loss, and negatively correlated ($P < 0.01$) with water-holding capacity and shear force. Moreover, shear force was found significantly ($P < 0.01$) correlated with the water - holding capacity. Saňudo *et al* (2004) found that, the increase in myofibrillar fragmentation is indicative of the amount of tenderisation that has taken place in meat.

The positive changes in meat quality characteristics tested in this study indicate improvement of the tenderness and acceptability of it. Boleman *et al* (1995) and Wheeler *et al* (1991) also drew the same results. It is concluded that injection to mature Somali camel meat with calcium chloride enhanced tenderness and improved the quality attributes of the meat. It could develop as methodology in order to overcome the problems of inferior quality of mature camel meat.

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