





Effect of aging and brine injection on meat quality characteristics of the one-humped camel (*Camelus dromedarius*) longissimus muscle

Gamaleldin Mustafa Suliman ^a, Abdullah Naser Al-Owaimer ^a, Elsayed Osman Swellum Hussein ^a,
Mohammed Qaid ^a and Hamdi Ahmed^b

^aDepartment of Animal Production, College of Food and Agricultural Sciences, King Saud University, Riyadh, Saudi Arabia; ^bSchool of Animal and Comparative Biomedical Sciences, College of Agriculture and Life Sciences, University of Arizona, Tuscon, AZ, USA

ABSTRACT

This study was conducted to investigate the effect of wet aging and brine injection on meat quality attributes of the one-humped camel. Both *longissimus thoracis* muscles of eight male camels were collected; the right muscle of each carcass was used for aging (A) only where no brine (B) injection applied, and the left muscle was brine-injected with 250 mM food-grade CaCl_2 at 5% (wt/wt). The aged muscles were cut into steaks, vacuum-packaged, and stored at 2°C for 3, 7, or 10 days. The injected muscles were also treated as the aged muscles. Wet aging had significant effects ($p < 0.05$) on the ultimate pH_u , drip loss (DL), water-holding capacity (WHC), shearing force, and myofibril fragmentation index (MFI). Brine injection also significantly affected ($p < 0.05$) the ultimate pH_u , DL, WHC, and MFI. Therefore, wet aging and brine injection could be applied in a combination to enhance the quality attributes of camel meat.

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Introduction

Tenderness of meat ranks among the top three attributes, in addition to juiciness and flavour, that consumers seek in meat and meat products. In certain circumstances, meat from different animal species need to be enhanced regarding quality parameters and palatability. Two of these methodologies are aging (conditioning) and brine injection.

In a study by Suliman et al. (2015), meat tenderness of three age groups of camel was improved as post-mortem aging days increased. Obuz et al. (2014) concluded that postmortem wet aging is very effective in enhancing tenderness of Holstein meat and lead to better palatability attributes. Generally, aging whether wet or dry was found to improve meat quality attributes (Kim et al. 2019). In aging process, the meat tenderness is improved due to proteolysis of the myofibrillar protein and degradation of structural proteins (Aaslyng and Meinert 2017).

The use of calcium to improve tenderness has been well investigated (Koohmaraie et al. 1988, 1989, 1990). The mechanism underlying tenderness improvement is the activation of the calpain proteolytic system that hydrolyzes key structural myofibrillar proteins during postmortem aging. It is known that calcium injection tenderizes meat by inducing m-calpain activity, resulting in a greater amount of protein degradation than using μ -calpain alone (Koohmaraie et al. 1988). Wheeler et al. (1991) conducted two experiments to determine the effect of calcium chloride (CaCl_2) injection on the tenderness of round muscles from *Bos indicus* bulls and late castrated

steers. They observed that CaCl_2 injection reduced the shearing force (SF) value at days 1, 8, and 14 compared to that in the non injected controls. In another study, Milligan et al. (1997) collected 20 standard beef round muscles to examine the effects of CaCl_2 injection and the degree of doneness on inside round roasts. The results showed that roasts injected with CaCl_2 were more tender as demonstrated by higher initial and sustained tenderness scores and decreased Warner-Bratzler SF values. Pringle et al. (1999) reported that CaCl_2 injection affected calpain proteinase system and meat tenderness by reducing the activity of calpains and calpastatin when using three different breeds of steers processed at a slaughter. They concluded that CaCl_2 injection can be used to improve meat tenderness. Previous studies have demonstrated that injection at 24 or 48 h with 5% 200 mM CaCl_2 could be applied without causing detrimental effects on palatability (Wheeler et al. 1993; Diles et al. 1994; Kerth et al. 1995; Lansdell et al. 1995). Hence, the present study was conducted to improve meat quality characteristics of one-humped camel using wet aging and brine injection.

Materials and methods

Experimental animals, treatments, and care measures

Eight one-humped male camels of similar background with an average weight of 250 ± 3 kg and aged 2 years \pm 2 months were used in this study. Immediately after slaughter, the *longissimus thoracis* (LT) muscle was removed from both sides of the

carcass of the animal and immediately transported to the Laboratory of Animal Production Department, College of Food and Agriculture Sciences, King Saud University. After 24 h of chilling at 4°C, muscle samples were prepared by removing external fats, ligaments, and tendons whenever possible. Then, the right muscle of each carcass was used for aging (A) only where no brine (B) injection applied, and the left muscle was brine-injected with 250 mM food-grade CaCl_2 at 5% (wt/wt). The injection was applied using a 50-mL syringe with a needle inserted into the muscle at different sites (as many as possible) to ensure even dispersion of the solution. Distilled water at 22°C was used to prepare the CaCl_2 solution. The muscle sample was initially weighed, then injected with the brine, and allowed to set for 5 min. Finally, the sample was reweighed to assure reaching the target proposed weight (5% more of the original weight). After that, each muscle was cut into 4 portions with same size and shape. Then each portion of the left muscle was cut further into 2 steaks (approximately 300 g and 2-cm thickness), vacuum-packaged, labelled, and aged without brine injection at 2°C for 0 day (A0), 3 days (A3), 7 days (A7), and 10 days (A10). The brine-injected right muscle was also prepared as the left muscle and stored at 2°C for 0 day (B0), 3 days (B3), 7 days (B7), and 10 days (B10). Thereafter, all the steaks (aged and brine-injected) were frozen at (−21°C) following the appropriate aging time.

This study was performed according to the guidelines of work on living animals proposed by the Research Ethics Committee (REC), King Saud University, Saudi Arabia.

Meat quality measurements

Ultimate pH_u and colour parameters

The colour parameters of the CIELAB Colour System (1976), L^* (lightness), a^* (redness), and b^* (yellowness), were determined using a Chroma meter (CR-400 Konica Minolta, Tokyo, Japan). The ultimate pH_u after 24 h and 3, 7, and 10 days postmortem was measured directly in the muscle using a microprocessor pH -Meter (Model: HI-99163; Hanna Instruments, Woonsocket, Rhode Island, USA). Two readings were taken in each measurement of colour and pH , and then the mean value was calculated for each carcass. The muscle samples were left for 30 min to undergo blooming before colour readings were recorded.

Drip loss

Drip loss (DL) was determined as a percentage of purge weight over sample weight in the LT muscles by weighing the samples 20 min after slaughter. They were then placed in plastic bags and left in a cooler (4°C) for 48 h. The samples were then reweighed to determine the DL values as a percentage based on the initial sample weight.

Cooking loss

Frozen chops were thawed overnight at 4°C, after which 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 (CL) as the difference between the initial and final weights.

Water-holding capacity

The water-holding capacity (WHC) was measured according to the method described by Wilhelm et al. (2010). Two replicates weighing approximately 2 g were collected from the muscle and cut into cubes. Then, the sample was placed between two filter papers and two Plexiglas and left under a 10-kg weight for 5 min. The sample was then reweighed, and the WHC was calculated as the difference between the initial and final weights.

Shearing force

The cooked samples used for determining CL were reused to evaluate SF as described by Wheeler et al. (2005). The samples were cooled to room temperature (21°C), and then five 1.27-cm-diameter round cores were removed from each muscle sample parallel to the longitudinal orientation of the muscle fibres. The cores were obtained using a handheld coring device. SF was determined as the maximum force (kg) perpendicular to the fibres using a texture analyzer (TA-HD-Stable Micro Systems, England) equipped with a Warner-Bratzler attachment. The crosshead speed was set at 200 mm/min.

Sarcomere length

The sarcomere length (SL) was measured as described by Cross et al. (1981) and Fleeter et al. (1985). Three longitudinal muscle sample cores (3 cm × 3 cm × 2 cm) were removed. The cores were placed in scintillation vials. Glutaraldehyde solution (5%) was added to the muscle bundle and fixed for 4 h at 4°C. Then, the glutaraldehyde solution was poured off and replaced with 0.2 M sucrose solution. The samples were then fixed overnight at 4°C. A sample was removed from the vial, and a fibre muscle bundle (1–2-mm-thick) was dissected free of its fibrous attachment for 3–4 cm along its course. All other attachments were left intact. Then, several fibres were excised using tweezers, placed on a microscope slide, and spread apart, followed by the addition of a small amount of sucrose solution to the slide. After placing a cover slip on the slide, it was placed on a laser (2 mW Helium–Neon Laser, A = 6320, beam size = 0.5 mm) platform and moved around until the laser diffracted on the sarcomere. To determine the SL, the distance between sarcomeres was measured in mm. A total of 10 sarcomeres were measured, and the mean value was calculated. SL was determined using the following equation:

$$\mu = (0.6328 \times D \times (\sqrt{(T/D)^2 + 1}))/T$$

where D = distance from the specimen to the diffraction pattern screen in mm (100 mm); T = spacing between diffraction bands in mm.

Myofibril fragmentation index

Myofibril fragmentation index (MFI) was determined as described by Al-Owaimer et al. (2014) based on the method outlined by Culler et al. (1978). Briefly, approximately 4 g of the muscle sample was scissor-minced and then homogenized (Ultra Turrax; IKA-Werke, Staufen, Germany) with 40 mL of a cold isolating MFI buffer. The absorbance of a 0.5 mg/mL solution was read at 540 nm using HACH DR/3000 Spectrophotometer, USA. MFI was calculated by multiplying the absorbance value and the dilution factor (200).

Statistical analysis

The study was set in a randomized block design (RBD) whereas the results were statistically analysed using one-way ANOVA of the SPSS program package (v 22). Mean differences were separated using Duncan's multiple range test. The model used was as follows:

$$Y_{ij} = \mu + \alpha_i + \beta_j + \epsilon_{ij}$$

where

Y_{ij} = observation of i at j

μ = overall mean

α_i = treatments effects

β_j = block effects

ϵ_{ij} = error residual

i = treatment

j = block

Results and discussion

Table 1 shows the quality attributes of the one-humped camel meat subjected to wet aging. Wet aging had significant effects ($p < 0.05$) on the ultimate pH_u , DL, WHC, SF, and MFI. There were no significant differences among the treatment groups with respect to colour parameters (L^* , a^* , and b^*), CL, and SL. Wet aging for 7 days (A7) resulted in significantly ($p < 0.05$)

higher ultimate pH_u (5.8), followed by $A_{10} > A_0 > A_3$. The A_3 group exhibited the lowest ultimate pH_u value (5.50) among the treatment groups. Wet aging increased the DL of camel meat with an increase in the aging period. The highest DL ($p < 0.05$) of 4.11% was found at 10 days of wet aging (A_{10}), whereas the lowest value (2.41%) was found at 3 days of aging (A_3). There was no significant difference in DL between A_3 and A_7 . These results were consistent with those reported by Abdelhadi et al. (2013) who observed significant increases in DL with increasing aging period. In contrast to current results, they reported nonsignificant differences in the ultimate pH , colour parameters, and WHC. CL and WHC were decreased in their study with increasing aging period. This change was statistically significant ($p < 0.05$) for WHC but not for CL. The control group (A_0) exhibited the highest WHC and CL values, which reflected the typical association between the two parameters, i.e. when the ratio of the former increases, the percentage of the latter also increases. The highest and lowest WHC values in A_0 and A_{10} groups respectively coincided with the highest ($p > 0.05$) and lowest ($p > 0.05$) CL% of the same treatment groups. These results were comparable to those reported by Suliman et al. (2020) who showed that aging had a significant impact on the expressed juice quantity, but not on CL. SF and MFI were significantly ($p < 0.05$) different among the treatment groups. As the aging period increased, the SF decreased, but MFI increased. This result was in agreement with that reported by Zhou et al. (2018). The highest value (40.80 N) of SF was observed in the A_0 group, whereas the lowest value (24.42 N) was observed in the A_{10} group. Conversely, the A_0 group showed the lowest MFI value (42.58), and the A_{10} group showed the highest MFI value (88.65). This result was consistent with that reported by Suliman et al. (2020) who investigated the meat quality characteristics of Arabian camel at different ages and postmortem aging periods. Jouki and Khazaei (2011) also reported improvement in camel meat tenderness with increasing aging period. The calpain system significantly controls the regulation of proteolysis of muscle proteins during postmortem periods, which results in improvement of meat tenderness (Huff-Lonergan and Lonergan 2005). In this context, the fragmentation of cytoskeletal proteins can be examined by determining MFI. Warriss (2000) reported the presence of a direct correlation between MFI and SF, wherein as SF decreases, MFI increases, indicating an improvement in tenderness. The finding of increasing MFI with increasing aging period in the present study is consistent with that reported by Marino et al. (2013) and Suliman et al. (2020). The findings of other researchers (Whipple et al. 1990; Olson and Parrish Jr 1997; Vestergaard et al. 2000; Rajagopal and Oommen 2015) also support the current results in showing the correlation among SF, MFI, and meat tenderness. Although the treatments did not cause any significant differences among them regarding SL, the A_{10} group demonstrated the highest ($p > 0.05$) SL value compared with the other treatment groups. This SL result was coherent with that of SF and MFI of the same group. As observed in our study, SF was found to correlate negatively with SL (Hostetler et al. 1972; Fausto et al. 2017) and positively with MFI (Fausto et al. 2017).

Table 2 shows the quality attributes of brine-injected aged meat of the one-humped camels. The ultimate pH_u , DL, WHC,

Table 1. Effect of wet aging on the meat quality attributes of the one-humped camels ($n = 16$).

Parameter	Wet Aging Treatments				SEM
	A0	A3	A7	A10	
pH_u	5.60 ^{ab}	5.50 ^b	5.80 ^a	5.70 ^a	0.03
Colour Parameters:					
L^*	42.70	41.37	42.69	40.65	0.82
a^*	15.80	18.02	17.55	18.92	0.57
b^*	8.19	8.28	8.40	9.52	0.44
DL%	NA	2.41 ^b	3.39 ^{ab}	4.11 ^a	0.34
CL%	34.41	34.32	33.40	29.21	0.99
WHC	1.14 ^a	1.07 ^b	1.07 ^b	1.04 ^b	0.01
SF (N)	40.80 ^a	35.11 ^{ab}	29.52 ^{bc}	24.42 ^c	0.20
SL (μ m)	1.76	1.76	1.75	1.77	0.04
MFI	42.58 ^b	52.40 ^b	81.08 ^a	88.65 ^a	4.84

^{a,b,c}Mean values in the same row with different superscripts are significantly different at $p < 0.05$.

In this and in subsequent tables:

A_0 = no wet aging

A_3 = wet aging for 3 days

A_7 = wet aging for 7 days

A_{10} = wet aging for 10 days

SEM = Standard error of mean.

Table 2. Effect of brine injection on the quality attributes of the one-humped camel meat aged for different time periods ($n = 16$).

Parameter	Brine-Injected Treatments				SEM
	B0	B3	B7	B10	
pH_u	5.40 ^b	5.30 ^b	5.70 ^a	5.50 ^{ab}	0.04
Colour parameters:					
L*	44.56	41.34	41.16	41.68	0.71
a*	16.99	17.32	17.98	19.31	0.57
b*	10.50	8.91	9.70	10.29	0.41
DL%	NA	5.20 ^a	7.98 ^b	7.91 ^b	0.67
CL%	31.76	31.74	31.44	30.89	0.53
WHC	1.06 ^{ab}	1.08 ^a	1.08 ^a	1.04 ^b	0.01
SF (N)	34.32	32.27	29.52	27.56	0.17
SL (μ m)	1.74	1.78	1.74	1.83	0.03
MFI	68.64 ^c	70.34 ^{bc}	83.58 ^{ab}	88.11 ^a	2.67

^{a,b,c}Mean values in the same row with different superscripts are significantly different at $p < 0.05$.

In this and in subsequent tables:

B0 = brine injection, no aging

B3 = brine injection + wet aging for 3 days

B7 = brine injection + wet aging for 7 days

B10 = brine injection + wet aging for 10 days

SEM = Standard error of mean.

and MFI were significantly ($p < 0.05$) different among the treatment groups, whereas the colour parameters, CL, SF, and SL showed no significant differences. The presented results were consistent with those reported by Rajagopal and Oommen (2015) who showed that marination had no significant effect on either colour parameters or CL. Moreover, in contrast to our results, they did not find any significant difference in the ultimate pH_u and WHC as a result of marination with CaCl_2 . This difference in result could be attributed to the extended aging period and the higher concentration of CaCl_2 used in this study. The ultimate pH_u increased ($p < 0.05$) with the increase in the aging period of injected meat. The highest value (5.70) was observed in the treatment group B10, whereas the lowest value (5.30) was recorded in the treatment group B3. The increase in pH of meat through aging process could be assigned to the formation of nitrogen compounds due to proteolysis (Aksu et al. 2005). In agreement with these results, Rajagopal and Oommen (2015) reported that calcium chloride has increased pH of buffalo meat. In general, DL increased with the increase in the aging period of injected meat. The highest ($p < 0.05$) DL was detected in group B7, whereas the lowest DL was recorded in group B3. The increase in DL with aging period obtained in this study is attributed to the disintegrality of muscle proteins. Muscles have different oxidative potentials or degradative responses (denaturation) to storage or aging conditions that ultimately affect drip loss (Huff-Lonergan and Lonergan 2005). This because increased protein oxidation levels were directly linked with higher degrees of drip loss (Traore et al. 2012). CL was found to decrease linearly ($p > 0.05$) with increasing aging period of injected meat. The control group (B0) showed the highest CL, whereas the treatment group B10 showed the lowest CL value (30.89%). The CL is directly affected by WHC. As WHC ratio decreases (more water is held by the tissues), the CL decreases. WHC was found to be significantly ($p < 0.05$) different among the treatment groups. The brine injection groups that were subjected to aging for 3 and 7 days exhibited

the highest WHC ratio, indicating a lower capacity for water retention, whereas the B10 group showed the lowest WHC ratio that indicated good water retention capacity. These WHC results were typically copied with those of CL, where the lowest WHC ratio resulted in the lowest CL. Generally, salts cause a swelling of myofibrils ending at an increase in the water-holding capacity if the isoelectric point of the myofibrillar system is above 5. This comes as a result of the Cl^- ions binding to positively charged amino acid groups on myosin and/or actomyosin which finally leads to water accumulation (Hamm 1986). The treatment groups did not show any statistically significant difference in the SF and SL values. The lowest SF value was observed in the B10 group, indicating tender meat, compared to that in other treatment groups. This result was also consistent with that reported by Rajagopal and Oommen (2015) who observed an improvement in tenderness in marinated groups compared with non marinated groups. This result was also consistent with that of SL (1.83) for the same treatment group, which was the highest ($p > 0.05$) value indicating the topmost meat tenderness. The MFI value showed significant ($p < 0.05$) differences among the treatment groups. Again, the treatment group B10 showed the highest MFI value. This result along with the SF result demonstrated the superiority of this group over the remaining treatment groups with respect to meat tenderness. Although SL was not significantly different among the treatment groups, the brine-injected groups showed an increase in SL, where B10 exhibited the longest SL compared with the remaining groups. This result was partially comparable to that reported by Wang et al. (2018) who investigated the effects of chloride injections on the microstructure of beef muscle fibres and reported that SL was significantly longer than that in the control group.

The results of comparison of the meat quality traits of the one-humped camel subjected to either wet aging or brine injections are shown in Table 3. The treatments resulted in significant differences in the ultimate pH_u , DL, CL, WHC, SF, and MFI. The highest ($p < 0.05$) pH_u (5.8) was observed in the A7 group, whereas the lowest value (5.3) was recorded in the B3 group. The non aged and non injected group (A0) showed a higher ($p < 0.05$) pH_u value than that in the injected and non aged group (B0) and the injected and 3-day-aged group (B3). On the other hand, A7 treatment resulted in higher ($p < 0.05$) pH_u value than that with the treatments B0, B3, and B10. The A10 treatment group also demonstrated a trend that was similar to that of A7 in terms of pH_u . The B7 group showed the highest ($p < 0.05$) DL value (7.98%), followed by B10, whereas the A3 group showed the lowest DL value (2.40%), followed by A7. The A3 group showed statistically significant ($p < 0.05$) differences in DL percentage compared with the B3, B7, and B10 groups. The A7 treatment group also exhibited the same tendency as that of A3 group regarding DL compared with B3, B7, and B10 groups, whereas the A10 treatment group only showed significant ($p < 0.05$) differences compared with B7 and B10 groups. In particular, DL increased with increasing aging period also in the brine-injected aged samples. The DL result observed in the existing study was consistent with that reported by Bunmee et al. (2014). The highest ($p < 0.05$) CL percentage was exhibited by A0, followed by A3

Table 3. Comparison between wet aging and brine injection and their effects on the meat quality attributes of the one-humped camels ($n = 16$).

Parameter	Treatments								SEM
	A0	A3	A7	A10	B0	B3	B7	B10	
pH_u	5.60 ^{ab}	5.50 ^{bc}	5.80 ^a	5.70 ^a	5.40 ^c	5.30 ^c	5.70 ^{ab}	5.50 ^{bc}	0.03
Colour parameters:									
L*	42.70	41.37	42.69	40.65	44.56	41.34	41.16	41.68	0.54
a*	15.80	18.02	17.55	18.92	16.99	17.32	17.98	19.31	0.40
b*	8.19	8.28	8.40	9.52	10.50	8.91	9.70	10.29	0.31
DL%	NA	2.4 ^d	3.39 ^{cd}	4.11 ^{bc}	NA	5.20 ^b	7.98 ^a	7.91 ^a	0.41
CL%	34.41 ^a	34.32 ^a	33.40 ^{ab}	29.21 ^b	31.76 ^{ab}	31.74 ^{ab}	31.44 ^{ab}	30.89 ^{ab}	0.56
WHC	1.14 ^a	1.07 ^{bc}	1.07 ^{bc}	1.04 ^c	1.06 ^{bc}	1.08 ^b	1.08 ^b	1.04 ^c	0.01
SF (N)	40.80 ^a	35.11 ^{ab}	29.52 ^b	24.42 ^b	34.32 ^{ab}	32.27 ^{ab}	29.52 ^b	27.56 ^b	0.13
SL (μ m)	1.76	1.76	1.75	1.77	1.74	1.78	1.74	1.83	0.03
MFI	42.58 ^d	52.40 ^{cd}	81.08 ^{ab}	88.65 ^a	68.64 ^{bc}	70.34 ^{abc}	83.58 ^{ab}	88.11 ^a	2.83

^{a,b,c,d}Mean values in the same row with different superscripts are significantly different at $p < 0.05$.

Table 4. Correlations between meat quality variables (aging treatments).

DL%	WHC	CL%	SF	MFI
1	−0.44*	−0.34	−0.45*	0.45**
	1	0.09	0.58**	−0.51**
		1	0.26	−0.31
			1	−0.27
				1

Correlation is significant at $p < 0.05$ level (*) or at $p < 0.01$ level (**).

Table 5. Correlations between meat quality variables (brine-injected treatments).

DL%	WHC	CL%	SF	MFI
1	0.03	−0.15	−0.25	0.56**
	1	−0.06	0.28	−0.18
		1	0.40*	−0.01
			1	−0.37*
				1

Correlation is significant at $p < 0.05$ level (*) or at $p < 0.01$ level (**).

group, whereas the lowest value (29.21%) was observed in the A10 group, followed by the B10 group. The highest ($p < 0.05$) WHC ratio (1.14) was recorded in the A0 group, followed by B3 and B7 groups, whereas the lowest ratio (1.04) was observed in A10 and B10, followed by the B0 group. Consistent with the CL data, the highest WHC ratio resulted in the highest CL as a consequence of the weak ability to hold water. The opposite was true when the WHC ratio was at the lowest. The treatments led to significant differences in SF, where the lowest ($p < 0.05$) value (2.49 kg) was observed in the A10 group, indicating the most tender meat compared with the remaining treatment groups, followed by B10 group. The least tender meat was observed in the A0 group as it achieved the highest SF value (4.16). Moreover, the SF value in the A10 group was consistent with the highest ($p < 0.05$) MFI value (88.65) recorded in the same group. This was also true for the A0 group that showed the highest and lowest SF and MFI values, respectively. The SF and MFI values observed in this study differed from those recorded by Bunmee et al. (2014) who reported lower values than those in the brine-injected groups. This could be attributed to the age difference of used animals and/or the brine concentration between the studies. Although the treatment groups showed no significant differences among them regarding colour parameters and SL, the brine-injected and non aged group (B0) showed the highest value (44.56) of luminosity (L*) compared with the remaining treatment groups, followed by the non brine-injected and non aged (A0) group, whereas the treatment group A10 showed the lowest L* value (40.65). The aged groups A3 and A7 exhibited higher L* values than the brine-injected groups B3 and B7. This result was comparable to that reported by Bunmee et al. (2014) who stated that aging alone produced lighter meat than that in the CaCl₂-injected groups. The treatment group B10 showed the highest ($p > 0.05$) SL value (1.83 μ m) compared with the other groups, followed by the B3 group.

Table 4 presents the Pearson's correlations between the meat quality variables of wet aging treatments. DL showed a highly positive correlation ($p < 0.01$) with MFI, but negatively correlated ($p < 0.05$) with SF. Conversely, WHC correlated highly negatively ($p < 0.01$) with MFI and highly positively ($p < 0.01$) with SF.

The Pearson's correlations between the meat quality variables of brine-injected treatment groups are shown in Table 5. DL highly positively correlated ($p < 0.01$) with MFI, whereas SF correlated positively ($p < 0.05$) with CL and negatively ($p < 0.05$) with MFI.

Brine injection combined with aging might improve meat tenderness by reducing SF and increasing MFI. Moreover, increasing the aging period by up to 10 days increased the DL but decreased the SF of the one-humped camel meat. Hence, we recommend using a combination of aging and brine injection to enhance the quality attributes of camel meat.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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ORCID

Gamaleldin Mustafa Suliman  <http://orcid.org/0000-0001-9865-1589>
 Abdullah Naser Al-Owaimer  <http://orcid.org/0000-0003-4646-6124>
 Elsayed Osman Swellum Hussein  <http://orcid.org/0000-0001-8673-3026>
 Mohammed Qaid  <http://orcid.org/0000-0003-0934-9690>

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