

# Effect of lairage time after short distance transport on some biochemical stress parameters and meat quality of Karayaka lambs



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## SUMMARY

Sheep are transported for various causes such as sale, breeding and slaughter. Several potential stressors which impair the meat quality affect sheep during the transport. Lairage is a common commercial practise to get rid of transportation stress before slaughter.

The aim of this study was to determine the effect of three lairage period (0, 2, 4 h) on some blood biochemical parameters and meat quality characteristics after short distance unpaved transport.

A total of 25 single born, male, average 90 days of age Karayaka lambs was used. The lambs were loaded to trailer and 30 km of journey took 30 min for on unpaved road condition. Lambs were randomly divided into three groups. First group lambs slaughtered immediately after unloading (L0, n = 9), second group lambs kept in lairage for 2h (L2, n = 8) and third group lambs kept in lairage for 4h (L4, n = 8) before slaughter. Blood samples were taken immediately before slaughter.

There was no significant differences among L0, L2 and L4 groups in terms of meat color characteristics, except a\* and C\* values measured at 24 h and 7 d after cutting that were higher in L0 group than in L4 group.

Results of the current study indicate that lairage time (0, 2, 4 h) after short distance transport had significant influence neither on biochemical stress parameters nor on meat quality characteristics, except redness and chroma values. Therefore, when biochemical responses of lambs and meat quality characteristics are taken into consideration, it can be said that lambs could be slaughtered after short time transport with a less resting period. More detailed studies need to be carried out to determine the effect of short distance transport and short lairage period on blood biochemical parameters and meat quality characteristics.

## KEY WORDS

Animal welfare, Karayaka lambs, meat quality, blood parameters.

## INTRODUCTION

Sheep are always transported for various causes such as sale, breeding and slaughter. Several potential stressors which impair the meat quality affect sheep during the transport. These stressors may also cause about some alterations in blood constituents such as plasma concentration of creatine kinase (CK), lactate dehydrogenase (LDH), glucose and cortisol. Lairage is a common commercial practise to get rid of transportation stress before slaughter<sup>1</sup>. Length of lairage period shifts according to the programs at the slaughterhouse. The duration ranges from 0 h to 24 h or more.

The sheep population in Turkey is 31 million heads and approximately 19.5 million commercial sheep are transported and slaughtered annually<sup>2</sup>. As there are numerous slaughterhouses in Turkey (more than 900), most of the commercial lamb transportations are carried out with short distance. In addition, due to numerous commercial lambs slaughtering, lambs slaughter were performed after short lairage duration

or immediately after arrival especially summer season. Although there are many studies related with long distance transport and different lairage durations (between 6 h and 18 h), there are limited scientific data available on short distance transport and short lairage duration. The aim of the current study was to investigate the effect of three different lairage times (0, 2, 4 h) after short distance transport on unpaved road on some biochemical and meat quality characteristics of Karayaka lambs.

## MATERIALS AND METHODS

### Animals, Handling and Lairage Groups

The study was carried out on 25 clinically healthy Karayaka lambs (approximately 90 days old and 26.0±1.6 kg live weight). Lambs were randomly chosen from a private farm (in Atakum, Samsun province, Turkey). Lambs were housed indoor in fold from birth until transportation to the slaugh-

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terhouse. The livestock transporter (Ford Transit 350L), which had one axle and one floor was used in the present study. The size of the trailer was 2.10 m x 3.77 m and stocking density for lambs (0.32 m<sup>2</sup> / lamb) was within the range of values recommended by the European Commission. The animals were transported in July at the ambient temperature of 24°C and relative humidity of 68% during the transport. The average ambient temperature and relative humidity were 25°C and 66% during the lairage and slaughter. The temperature and humidity data supplied from a device (YCOM KMU-303). These values from loading to slaughter were within the range of thermo-neutral comfort zone values for sheep<sup>3</sup>.

A 30 km of journey started at 09:00 h and took 30 min. The lambs were transported from farm to slaughterhouse at low speeds without stops and sudden acceleration and deceleration on unpaved road. The lambs were loaded and unloaded by the same trained person throughout transport. Loading was performed as described by Ekiz et al.<sup>4</sup>. A ramp was used for unloading, and the ramp had suitable angle for lambs. The lambs were randomly divided into three groups after transportation. L0, lambs slaughtered immediately after unloading (n = 9); L2, lambs kept in lairage for 2 h (n = 8); and L4, lambs kept in lairage for 4 h (n = 8). The animals had free access to water, but were not fed in the lairage period.

### Blood sampling and biochemical analyses

Blood samples were taken through jugular venipuncture in Vacutainer tubes which were in EDTA coated. One sample was taken per lamb. The samples were taken just before slaughter in each lamb. Blood samples were collected by the same experienced person during the study period. Sampling from each animal was completed in <1 min intervals to reduce handling stress that may have affected the results. Samples were kept in cold storage for 2h and transferred to the biochemistry laboratory. The plasma was separated by centrifugation for 10 min at 1500 × g, frozen and stored at -25°C until use. Plasma levels of glucose, CK, LDH and ALT were determined with diagnostic kits (Auditdiagnostic, Cork, Ireland). A diagnostik ELISA direct immunoenzymatic kit (DiaMetra, Foligno, Italy) was used to determine the plasma concentrations of cortisol.

### Meat quality analyses

The lambs were slaughtered at the slaughterhouse by cutting the major blood vessels in the neck. The pH measurement of *longissimus dorsi* muscle was carried out between the 12th

and 13th thoracic vertebrae immediately after carcass dressing (pH<sub>0</sub>), after 45 min (pH<sub>45</sub>), and at 24h post slaughter (pH<sub>ult</sub>) using a portable pH meter (Testo 205, Testo Inc., Sparta, NJ). The *longissimus thoracis* muscle were dissected from the left side of the carcass at 24h postmortem for assessment of meat quality characteristics. The *longissimus thoracis* muscle were stored for 7 days at 4°C and used to determine meat quality characteristics such as colour parameters, water holding capacity (WHC) and the Warner-Bratzler shear force (WBSF) value. A modified Grau and Hamm method was used as described by Beriain et al.<sup>5</sup> to measure the WHC. Meat samples of *longissimus thoracis* muscle including the 5th and 11th thoracic vertebrae were utilized for determination of cooking loss (%). Samples packaged under vacuum were cooked as described by Honikel<sup>6</sup> and cooking loss was determined. Then, samples were prepared and shear force was measured by a device (Model 3343, Instron Corp., Norwood, MA, USA) equipped with a WBSF apparatus as described by Ekiz et al.<sup>4</sup>. Meat color (CIE L\*, a\*, b\*) was measured by using a Minolta chromometer (Model CR 400, Minolta Camera Co., Osaka, Japan). Light source, aperture size and observation angle were set illuminant D65, 8 mm and 2°, respectively. The chromometer was calibrated according to a standard white plate (Y = 93.8, x = 0.316, y = 0.3323). The colour was measured just after cutting, on the lean cut surface of 2.5 cm thick samples, on the 1st and 7th days of storage under continuous white light (750 lx) at 4°C. The chroma (C\*) and hue angle (H\*) were calculated as described by Wyszecki and Stiles<sup>7</sup>:

$$C^* = [(a^*)^2 + (b^*)^2]^{1/2}; H^* = \tan^{-1} (b^*/a^*).$$

### Statistical analyses

One-way ANOVA was performed to determine the effect of lairage time (0, 2 and 4 h) on biochemical stress parameters and meat quality characteristics. If the effect of lairage time was significant, Duncan's multiple range tests were applied to decide the significance of the difference.

## RESULTS

Means and standard errors (SE) for some biochemical parameters in three lairage time groups were given Table 1. The effect of lairage time on plasma concentrations of glucose, LDH, CK, ALT and cortisol were not significant (P>0.05). The effect of lairage time on meat quality characteristics were presented in Tables 2 and 3.

Lairage time had no significant influence on meat pH<sub>0</sub>, pH<sub>45</sub> and pH<sub>ult</sub> (P>0.05). There was also no significant effect of lairage time on WHC, cooking loss and WBSF (P>0.05). Similarly, differences among L0, L2 and L4 groups in terms of meat color characteristics were not significant, except a\* and C\* values measured at 24 h and 7 d after cutting of the samples. Meat redness and chroma values measured after 24 h and 7 d cutting in L0 group were higher than those of lambs from L4 group.

**Table 1** - Means and standard errors (SE) for Glucose, LDH (Lactate dehydrogenase), CK (Creatine kinase), ALT (Alanine aminotransferase) and Cortisol in different lairage time groups.

Characteristics	0 h lairage		2 h lairage		4 h lairage		Sig.
	Mean	SE	Mean	SE	Mean	SE	
Glucose, (mg/dl)	85.33	5.18	79.38	2.34	76.75	3.61	NS
LDH, (UI/l)	142.56	9.58	155.38	6.03	140.50	7.19	NS
CK, (UI/l)	140.67	12.49	120.38	11.68	115.63	12.07	NS
ALT, (UI/l)	16.67	1.27	15.00	0.78	14.88	0.79	NS
Cortisol, (ng/ml)	30.03	2.87	27.44	3.30	25.78	3.26	NS

NS = Not significant (P>0.05).

**Table 2** - Means and standard errors (SE) for pH, water holding capacity (WHC), cooking loss and Warner-Bratzler shear force (WBSF) values of *Longissimus dorsi* muscle in different lairage time groups.

Characteristics	0 h lairage		2 h lairage		4 h lairage		Sig.
	Mean	SE	Mean	SE	Mean	SE	
pH <sub>0</sub>	6.41	0.06	6.47	0.02	6.45	0.05	NS
pH <sub>45</sub>	5.97	0.08	6.05	0.06	6.19	0.08	NS
pH <sub>ult</sub>	5.52	0.02	5.58	0.02	5.55	0.02	NS
WHC, %	8.36	0.90	7.23	0.40	9.37	0.50	NS
Cooking loss, %	28.51	0.85	29.02	0.74	27.95	1.27	NS
WBSF, kg	3.47	0.11	3.72	0.12	4.08	0.26	NS

NS = Not significant (P>0.05).

**Table 3** - Means and standard errors (SE) for meat colour characteristics of *Longissimus dorsi* muscle in different lairage time groups.

Characteristics	0 h lairage		2 h lairage		4 h lairage		Sig.
	Mean	SE	Mean	SE	Mean	SE	
Colour parameters at 0 h							
(L*) <sup>0 h</sup>	40.68	0.53	38.74	0.81	38.11	1.03	NS
(a*) <sup>0 h</sup>	16.87	0.21	16.77	0.32	16.38	0.56	NS
(b*) <sup>0 h</sup>	1.55	0.25	0.84	0.23	0.68	0.31	NS
(C*) <sup>0 h</sup>	16.95	0.21	16.80	0.31	16.42	0.56	NS
(H*) <sup>0 h</sup>	5.26	0.86	2.95	0.86	2.42	1.07	NS
Colour parameters at 24 h							
(L*) <sup>24 h</sup>	42.71	0.47	42.82	0.49	42.85	0.56	NS
(a*) <sup>24 h</sup>	15.74 <sup>a</sup>	0.37	14.47 <sup>ab</sup>	0.39	13.91 <sup>b</sup>	0.32	*
(b*) <sup>24 h</sup>	5.93	0.22	6.01	0.23	5.82	0.19	NS
(C*) <sup>24 h</sup>	16.83 <sup>a</sup>	0.36	15.68 <sup>ab</sup>	0.37	15.08 <sup>b</sup>	0.30	*
(H*) <sup>24 h</sup>	20.66	0.80	22.64	0.99	22.74	0.79	NS
Colour parameters at 7 d							
(L*) <sup>7 d</sup>	41.16	0.60	40.37	0.66	40.62	0.73	NS
(a*) <sup>7 d</sup>	16.43 <sup>a</sup>	0.50	14.98 <sup>ab</sup>	0.53	13.56 <sup>b</sup>	0.23	**
(b*) <sup>7 d</sup>	6.84	0.31	6.28	0.28	5.83	0.28	NS
(C*) <sup>7 d</sup>	17.81 <sup>a</sup>	0.52	16.26 <sup>b</sup>	0.50	14.78 <sup>b</sup>	0.21	***
(H*) <sup>7 d</sup>	22.60	0.86	22.86	1.20	23.25	1.17	NS

NS = Not significant (P>0.05).  
<sup>a,b</sup> Means in the same line with different superscripts are significantly different (P<0.05).  
\*P<0.05; \*\*P<0.01; \*\*\*P<0.001.

## DISCUSSION

### Biochemical parameters

Cortisol and glucose increases can be used as indicator of stress. Similarly, CK, LDH and ALT increases in plasma can be indicated a preslaughter stress such as trauma, vigorous exercise and tissue damage during the transportation<sup>8</sup>. Liu et al.<sup>9</sup> studied the effects of lairage time (0, 2, 4, 6, 12, 24 and 48 h) after 8 h transport on some blood indicators and meat quality characteristics. They found that glucose, cortisol, and CK concentrations decreased from 0 h to 12 h, then the blood parameters increased after 12 h of lairage. Liste et al.<sup>10</sup> investigated effect of lairage time (0 h and 12 h) after 1 h road transport on lamb welfare and meat quality traits. They concluded

that the glucose and cortisol concentrations decreased, but CK concentration increased. Leme et al.<sup>11</sup> investigated the influence of the transport in open or closed compartments for road transport on cortisol as an indicator of stress in lambs. They carried out three different lairage time (0 h, 1 h and 3 h) after 1 h transport. They found that as the lairage time increased, the cortisol concentration decreased in transported open compartment. The effect of lairage time on glucose, cortisol, ALT, LDH, CK concentrations were not significant (P>0.05) in present study. These results were in conflict with reports of Liu et al.<sup>9</sup>, Liste et al.<sup>10</sup> and Leme et al.<sup>11</sup>, who detected decreased glucose and cortisol concentrations as lairage time increased. Shorter transport time of the current study compared with those studies might be a possible explanation of differences between studies, because increased fasting time might cause decreased glucose and cortisol concentrations<sup>12</sup>. However, Liste et al.<sup>10</sup> found that CK or LDH concentrations increased as lairage time increased. The result of the present study is not accordance with these studies. This discrepancy between results may be due to the differences in lairage period.

### Meat quality characteristics

Liu et al.<sup>9</sup> determined that lambs lairaged six different times (0, 2, 4, 6, 12 and 48 h) after 8h transport had pH<sub>ult</sub> values of 5.59; 5.64; 5.61; 5.60; 5.64 and 5.77, respectively. Liste et al.<sup>10</sup> stated that lambs performed two lairage

times after 1 h road transport had pH<sub>ult</sub> values of 5.65 and 5.68, respectively. Gallo et al.<sup>13</sup> investigated the effect of transport and lairage time on steers. The steers were transported by road to slaughterhouse for 3 h, and held in lairage for 3 h. They found that the pH<sub>ult</sub> value was between 5.6 and 5.7. The pH<sub>ult</sub> results of the authors were below 5.8. In present study, there was no significant effect of lairage time on meat pH<sub>0</sub>, pH<sub>45</sub> and pH<sub>ult</sub> values and pH<sub>ult</sub> values were always within the normal limits (≤5.8) for commercial meat quality.

Meat color, texture and WHC may be affected from final pH value. Therefore, pH<sub>ult</sub> is primarily indicator of commercial meat quality. Meat color is an important factor in choice of consumer for making a decision<sup>5</sup>. The effect of lairage time on L\*, b\* and H\* values were not significant at 24h and 7 d

after cutting ( $P>0.05$ ), while its influence on  $a^*$  and  $C^*$  values were significant ( $P<0.05$ ) in the present study. The  $L^*$  (42.71),  $a^*$  (15.74) and  $b^*$  (5.93) values measured at 24h after cutting in present study were similar to the  $L^*$  (39.40),  $a^*$  (11.45), and  $b^*$  (7.14) values of Liste et al.<sup>10</sup>. Teke et al.<sup>14</sup> determined similar  $L^*$  (39.01),  $a^*$  (16.08), and  $b^*$  (4.67) values with the current study. The effect of lairage time on WHC, cooking loss and WBSF value was not significant ( $P>0.05$ ) in current study. Similarly, Liu et al.<sup>9</sup> and Ferguson et al.<sup>15</sup> found non-significant effect of lairage time on cooking loss and WBSF. Liste et al.<sup>10</sup> determined that the shear force was not significantly affected by lairage time while WHC was affected. Our findings are usually in accordance with these results. The differences between our study and the study of Liste et al.<sup>10</sup> for WHC may be due to the difference in breed, carcass fatness or structure of connective tissue<sup>16</sup>.

## CONCLUSIONS

Results of the current study indicate that lairage time (0, 2, 4 h) after short distance transport had significant influence neither on biochemical stress parameters nor on meat quality characteristics, except redness and chroma values. Therefore, when biochemical responses of lambs and meat quality characteristics are taken into consideration, it can be said that lambs could be slaughtered after short time transport with a less resting period.

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