Duration of Preslaughter Stress in Winter on Physiological Responses and Meat Quality in Goats

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Abstract

Transportation conditions can significantly affect physiological status and meat quality in goats. This experiment was conducted to determine the effects of duration of preslaughter stress on physiological responses and meat quality in goats. Fifty-four uncastrated male Spanish goats (8-mo old; BW = 29.7 ± 2.03 kg) were randomly subjected to one of three treatments (TRT; n = 18 goats/treatment): (i) transported for 180 min, (ii) transported for 30 min, or (iii) held in pens (control) on two different days (Day). The ambient temperatures were -3.0 ± 1.0 ºC and 1.0 ± 1.0 ºC on day 1 and 2, respectively. Blood samples were collected before (covariate) and after transport for differential leukocyte count and plasma cortisol concentration determinations. Goats were slaughtered using humane procedures for meat quality analysis. Data were analyzed using PROC GLM in SAS with TRT and Day as factors. Cortisol concentrations were higher (P < 0.01) in both 180 min (117.7 ± 7.96 ng/mL) and 30 min (130.1 ± 8.05 ng/mL) transported groups compared to the control group (27.5 ± 7.59 ng/mL). Lymphocyte counts were lower (P < 0.01) in 180 min group compared to the other two groups, and the overall counts were also lower (P < 0.05) on Day 1 compared to Day 2. The initial Longissimus muscle pH (15 min) was lower on Day 1 (6.79 ± 0.04) compared to Day 2 (6.94 ± 0.05) and the final pH (24 h) was higher on Day 1 (6.31 ± 0.04) than on day 2 (6.14 ± 0.04). Treatment did not influence live or carcass weights, nor did it affect the L*, a*, and b* values of loin chops. The results indicate that ambient temperature during transport may be more important in determining stress responses and muscle pH decline than duration of transportation in goats during winter.

Key Words: Goats, Stress, Transportation

Introduction

Preslaughter stress can greatly affect muscle metabolism and negatively impact meat quality characteristics in goats (Kannan et al., 2003). Depletion of muscle glycogen prior to slaughter can interfere with the normal course of pH decline and conversion of muscle to meat. Transporting goats from farm to processing plant invariably results in elevated stress levels, as indicated by plasma cortisol concentrations (Kannan et al., 2003). The duration of transportation of goats combined with an extreme ambient temperature can have a significant effect on their physiological status. In extreme cold weather, the primary mechanisms for heat generation in goats are by shivering and non-shivering thermogenesis by muscle (Schaeffer et al., 2001). Data on the effects of transportation of goats in winter weather on physiology and meat quality are very limited.

Objective

This experiment was conducted to determine the effects of duration of preslaughter transportation in winter weather on physiological responses and meat quality in goats.

Methods

A total of fifty-four uncastrated male Spanish goats (8-mo old; BW = 29.7 ± 2.03 kg) were randomly subjected to one of three treatments (TRT; n = 18 goats/treatment): (i) transported for 180 min, (ii) transported for 30 min, or (iii) held in pens (control) on two different days. The ambient temperatures were -3.0 ± 1.0 ºC and 1.0 ± 1.0 ºC on Day 1 and 2, respectively. Blood samples were collected before and after transport for differential leukocyte count and plasma cortisol concentration determinations. Cortisol concentrations were determined using capture ELISA in 96-well micro titer plates using the Cortisol ELISA Kit (Abnova, Taipei, Taiwan). Goats were slaughtered using humane procedures for meat quality analysis. *Longissimus* muscle was used to determine initial (15 min postmortem) and final (24 h postmortem) pH values. Loin chops were used for determination of CIE L* a* b* color coordinate values. Data were analyzed using PROC GLM in SAS with TRT and Day as independent variables. The pre-transport values were used as covariates for cortisol and leukocyte count analyses. When significant by ANOVA (P < 0.05), the means were separated using the LSD test.

Results

Cortisol concentrations were higher (P < 0.01) in both 180 min (117.7 ± 7.96 ng/mL) and 30 min (130.1 ± 8.05 ng/mL) transported groups compared to the control group (27.5 ± 7.59 ng/mL; Figure 1). Lymphocyte counts were lower (P < 0.01) in 180 min group compared to the other two groups, and the overall counts were also lower on Day 1 compared to Day 2 (Figure 2). However, neutrophil counts were not affected by TRT or Day (Figure 3). The initial Longissimus muscle pH was lower on Day 1 compared to Day 2 and the final pH was higher on Day 1 than on Day 2 (Table 1). Treatment did not influence live or carcass weights, nor did it affect the L*, a*, and b* values of loin chops (Table 1).

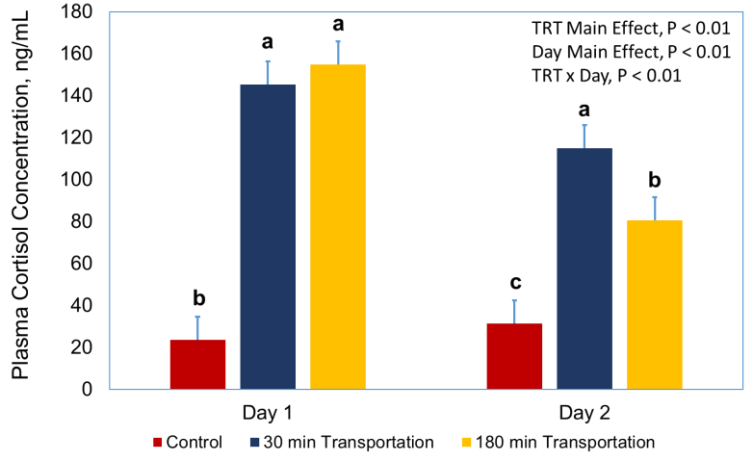

Figure 1. Mean (± SEM) plasma cortisol concentrations in goats subjected to transportation stress. Control goats were not transported, but held in pens. [abc]Bars within a cluster with different letters differ significantly (P < 0.05) by LSD test.

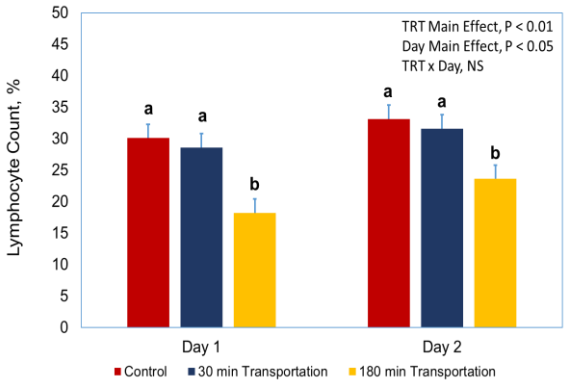

Figure 2. Mean (± SEM) lymphocyte counts in goats subjected to transportation stress. Control goats were not transported, but held in pens. [ab]Bars within a cluster with different letters differ significantly (P < 0.05) by LSD test.

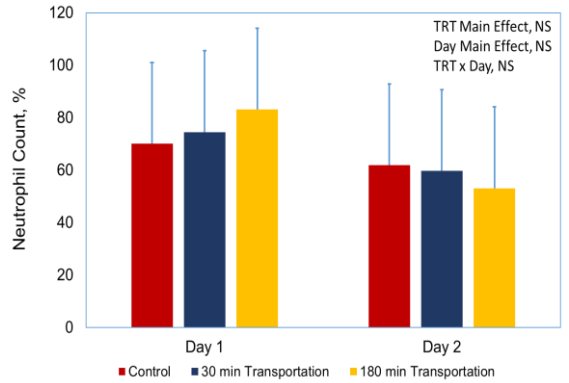

Figure 3. Mean (± SEM) neutrophil counts in goats subjected to transportation stress. Control goats were not transported, but held in pens.

Table 1. Effects of transportation stress on meat quality and carcass characteristics. Control goats were not transported, but held in pens.

Day	Duration of Transportation			Day Main Effect Means	P-value (ANOVA)		
	Control	30 min	180 min		TRT	Day	TRT x Day
Initial pH (15 min postmortem, *Longissimus* muscle)							
1	6.70 ± 0.76	6.81 ± 0.076	6.88 ± 0.076	6.79 ± 0.044b	0.1867	0.0303	0.6824
2	6.89 ± 0.076	6.99 ± 0.080	6.95 ± 0.076	6.94 ± 0.045a			
Final pH (24 h postmortem, *Longissimus* muscle)							
1	6.29 ± 0.067	6.30 ± 0.067	6.35 ± 0.067	6.31 ± 0.039a	0.6024	0.0028	0.6241
2	6.09 ± 0.067	6.21 ± 0.071	6.12 ± 0.067	6.14 ± 0.039b			
Color L* value							
1	36.9 ± 1.12	38.7 ± 1.12	37.5 ± 1.12	37.7 ± 0.65	0.1761	0.9432	0.3461
2	38.6 ± 1.12	38.9 ± 1.19	35.8 ± 1.12	37.8 ± 0.66			
a* value							
1	8.8 ± 0.62	9.3 ± 0.62	9.5 ± 0.62	9.2 ± 0.36	0.4800	0.4764	0.1740
2	10.0 ± 0.62	10.3 ± 0.65	8.5 ± 0.62	9.6 ± 0.36			
b* value							
1	9.7 ± 0.48	9.9 ± 0.48	9.8 ± 0.48	9.8 ± 0.28b	0.1089	0.0025	0.1203
2	11.5 ± 0.48	11.8 ± 0.51	9.9 ± 0.48	11.1 ± 0.28a			
Hot Carcass Weight, kg (30 min postmortem)							
1	11.6 ± 0.61	12.1 ± 0.61	11.6 ± 0.61	11.7 ± 0.35	0.8868	0.5968	0.7362
2	11.3 ± 0.61	11.3 ± 0.64	11.8 ± 0.61	11.5 ± 0.36			
Cold Carcass Weight, kg (24 h postmortem)							
1	11.3 ± 0.65	11.9 ± 0.65	11.3 ± 0.65	11.5 ± 0.38	0.8906	0.6823	0.7494
2	11.1 ± 0.62	11.1 ± 0.69	11.6 ± 0.65	11.3 ± 0.38			

[ab]Means (± SEM) for a variable within a column with different superscripts differ significantly (P < 0.05) by LSD test.

Conclusions

Ambient temperatures below freezing during transportation can have an additive effect on stress levels in goats as indicated by plasma cortisol concentrations. The overall cortisol concentrations were higher on Day 1 when the temperature was -3.0 ºC than on Day 2 (1.0 ºC). The effect of both duration of transportation and lower ambient temperature can have a prominent effect on lymphocyte counts in goats. Exposure of goats to below freezing temperatures prior to slaughter can significantly affect the pattern of muscle pH decline during the 24 h postmortem period that can have a negative effect on meat quality characteristics. Exposure to adverse temperature prior to slaughter may have more prominent effects on stress responses and muscle pH decline in goats and may override the effects of transportation.

References

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