

# EFFECTS OF TRANSPORTATION PERIOD AND WAITING BEFORE SLAUGHTER ON BEHAVIOUR AND MEAT QUALITY OF LAMBS

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**Abstract** – The aim of this study was to evaluate the effects of different transport times and pre-slaughter waiting on stress levels, behavior and meat quality of lambs. Thirty two lambs,  $127 \pm 7$  days of age, averaging  $30.4 \pm 2.06$  kg of body weight were subjected to transport times of 2 or 6 hours. After these periods, blood of the animals was collected and then lambs remained for 12 or 24 h on pre-slaughter waiting, while their behavior was assessed. Shortly after the stunning, another blood sample was collected and used to measure cortisol levels. Displacement activity, rumination and interaction between animals differed between the 24h and 12h waiting periods ( $P < 0.05$ ). The waiting period of 12h also affected ( $P < 0.05$ ) the quality of meat for the variables shear force, L \* and b \*. There was no interaction effect ( $P > 0.05$ ) between transportation and waiting periods. Although the 24h waiting period has caused a slight toughness of the meat when compared with the 12h period, it favors animal welfare based on their behavior assessment

**Key Words** – cortisol, meat softness, slaughter.

## I. INTRODUCTION

The production of food from animal origin is assessed currently both inside and outside the farm. Stress can interfere in animal welfare. Some of the stress factors that can be observed are the moving of animals inside the property, when there is need to change individuals between groups [1], as well as the transport from the property to the slaughterhouse [2]. For sheep, the shortest transport period (30 minutes to 1h), increases blood cortisol levels [3], while in longer journeys, these levels return to baseline level [4]. The waiting period in slaughterhouse is necessary to allow the animals to rest from the journey which they were subjected and to deflate their digestive

tract [5], and also enable behavioural activities promoting their welfare. This study aimed to evaluate the effects of different times of transport and pre-slaughter waiting on stress levels, pre-slaughter behaviour and the quality of lamb meat.

## II. MATERIALS AND METHODS

The study was approved by the Ethics Committee on Animals Use (CEUA protocol number: 2014-10) from "Luiz de Queiroz" Agriculture College - ESALQ / USP.

Thirty two lambs with  $127 \pm 7$  days of age and average body weight of  $30.4 \pm 2.06$  kg were used, divided into two blocks (16 animals) with 21 days of execution interval between them, adopting the same procedures for both blocks as follows: Eight animals were transported for a 6h period and the other eight animals for 2h. The available area for each animal during transportation period was  $0.75 \text{ m}^2$  and at the end, they were manually unloaded from the truck and randomly allocated into two collective pens ( $15 \text{ m}^2$  each), distinguishing between waiting periods of 12 or 24 hours. Blood samples were collected by venipuncture of jugular vein, using vacuum tubes for evaluation of cortisol levels. Behavioural data during the waiting periods were collected through instant collection [6], considering the body posture (lying and standing) and behavioral activities (displacement, water intake, rumination, interaction among animals, other activities (urinate, defecate, bleat) and no apparent activity (animals remained stopped for no apparent movement)). At the end of the stipulated waiting period, the animals were weighed and stunned (using a captive bolt pistol) followed by bleeding through jugular vein section, from where another blood sample were collected for serum

cortisol analyzes. Serum samples were analyzed in duplicate by radioimmunoassay (RIA) following the methodology of commercial kit (MP Biomedicals, LLC, Orangeburg, New York) in an automatic gamma counter (Wizard. 2; Perkin Elmer, Downs Grove, IL USA). *Longissimus dorsi* muscle was removed and exposed to air for 30 minutes then three measurements were taken at different points to obtain the average meat color value, using a spectrophotometer (model CM-600d MINOLTA) for reading the parameters L\* (lightness), a\* (red intensity) and b\* (yellow intensity) as indicated by Macdougall [7]. Four *Longissimus dorsi* steaks were heated in oven until the internal temperature reached approximately 75 °C and then cooled to the inner temperature of 40 °C. Three cylindrical samples of 1.27 cm diameter of each steak were taken to measure the maximum shearing force using a texturometer (TA-XT 2i) coupled with Warner Bratzler blade (3 mm thick). The equipment was calibrated with standard weight of 5 kg with a traceable standard. The device descent speed was 200 mm / min [8]. It was considered as the final value the average of 12 readings expressed in kgf.

For statistics, the experimental design was factorial with two periods of transport and two waiting periods in two blocks (different dates). Analysis of variance was performed by PROC GLM of SAS ® (SAS v. 9.2® Cary, NC) and means were compared by the Tukey test at 5% probability. Relative frequencies of each behavioural activity were used, to make it possible to compare periods of transportation and waiting before slaughter.

### III. RESULTS AND DISCUSSION

There was no interaction between transport and waiting periods, and both transport periods did not influence ( $P > 0.05$ ) behavioral responses such as cortisol levels and meat quality assessments. The results are shown in Table 1. According to Fisher et al. [9], sheep have quick adaptation to transport conditions during a travel, supporting the results found in this study. The serum cortisol increases in sheep after loading at the beginning of the route and decreases to basal values [9, 10], the decrease in cortisol levels occurs within about one hour [4].

Table 1. Body posture, behavior and meat quality of lambs subjected to two periods of transport and two periods of pre-slaughter waiting.

VARIABLES	Transport			Waiting			SEM
	2 hours	6 hours	P	12 hours	24 hours	P	
Body Posture (%)							
Lying	59.7	56.6	NS	54.4	61.9	NS	2.6
Standing	40.3	43.4	NS	45.6	38.1	NS	2.6
Activities (%)							
Displacement	7.5	7.6	NS	9.6	5.5	**	0.8
Water intake	0.4	0.4	NS	0.4	0.5	NS	0.2
Rumination	26.7	28.9	NS	23.6	32.0	**	1.8
Interaction among animals	5.7	6.7	NS	4.6	7.8	**	0.9
Other activities	15.5	15.5	NS	15.8	15.2	NS	1.2
No apparent activity	44.2	40.9	NS	46.1	39.0	NS	2.4
Stress (µg / dL)							
Cortisol after transport	0.22	0.29	NS	0.23	0.29	NS	0.1
Cortisol after waiting	0.18	0.17	NS	0.15	0.20	NS	0.1
Meat Quality							
Shear force (Kgf)	2.6	2.5	NS	2.3	2.9	*	0.2
Cooking loss (%)	10.5	11.8	NS	11.5	10.9	NS	0.9
pH <sub>0</sub>	6.1	6.1	NS	6.1	6.1	NS	0.1
pH <sub>24</sub>	5.4	5.4	NS	5.4	5.4	NS	0.02
L*	43.7	43.0	NS	44.5	42.2	*	0.7
a*	11.9	11.7	NS	12.1	11.6	NS	0.3
b*	13.2	12.8	NS	13.5	12.5	*	0.3

NS = Not Significant; \* =  $P < 0.05$ ; \*\* =  $P < 0.01$

Waiting periods influenced both behavioral activities (displacement, rumination and interaction among animals) and the meat quality variables (shear force, intensity L \* and b \*).

The 12 hours pre-slaughter waiting increased the displacement activity ( $P = 0.001$ ), which may indicate a greater discomfort with the environment [12]. According to World Organization for Animal Health [13], the animals have high sense of olfaction, and may react differently to a different smell to which they were subjected. The 12h pre-slaughter hours also decreases rumination activity ( $P = 0.002$ ). The environmental effect and hence the low level of welfare can be confirmed with the lowest rumination activity, as well as less interaction between the animals from the 12 hours waiting group when compared to 24 hours waiting group. Rumination activity is indicative of a high degree of ruminant's welfare, and according to Balbinotti et al. [14], that activity associated with lying posture demonstrates better animal welfare conditions. Interactions between animals was lower ( $P = 0.01$ ) in the 12 h waiting group. Although a lower interactions has been observed, the data demonstrated how the animals were comfortable to the new environment, since they did not show any aversive behaviour, such as headers, and kept the behaviour of 'play' with each

other, which was common in their place of origin. The behavioural characteristics of some animals can trigger the behaviour of the entire group [15], as well as new and / or enriched environments increase motivation for interaction between animals, but tends to decrease in a short time [16]. It is very likely that the lack of environmental enrichment period and the average ambient temperature explains the less interaction between the animals from the 12h waiting period as shown in Figure 1.

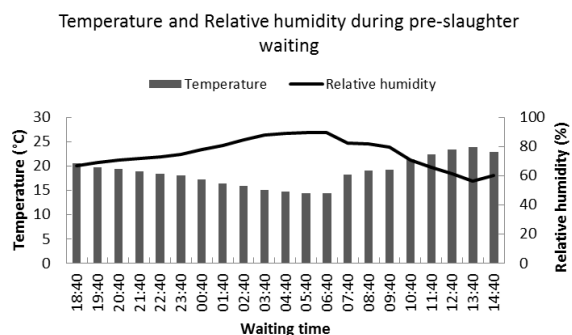


Figure 1. Mean temperature and relative humidity during the waiting periods of 12 or 24 hours before slaughter

For meat softness, evaluated by shear force, the values are characteristic of soft meat [17]. Although they have good softness, significant difference ( $P = 0.02$ ) can be observed between the two pre-slaughter (12 or 24h) periods, with lower values for the 12h period. This result may be connected with the frequency of interaction between the animals. Studies have reported that the texture difference may be related to exercises made by animals [18].

The meat color was influenced by waiting period. Animals which have remained for 12 hours waiting before slaughter had higher brightness content ( $L^*$ ) as well as higher levels of yellow ( $b^*$ ) when compared to animals maintained on 24 hour pre-slaughter waiting period. In both periods of waiting,  $L^*$  and  $b^*$  values were superiors to those reported in the literature [19], ranging between 31.36 to 38 for  $L^*$ , and 3.34 to 5.65 for  $b^*$ . According to Sañudo [20], when  $b^*$  intensity is around 9 to 11, these are indications that the shade of red are closer to the yellow region. Desirable characteristics of meat, such as color and tenderness are pH dependent [21]. In the present study, the initial and final pH values were not

affected ( $P > 0.05$ ) by periods of transportation and waiting in which the animals were subjected, and are within the range considered as normal for sheep [22]. Studies reported that lambs that have undergone stress before slaughter present values of 5.8 [23, 24], which was not observed in this study.

#### IV. CONCLUSION

Although the 24h waiting period induces a slight toughness of the meat when compared to 12h waiting period, it promotes better welfare as related to the behaviour of the animals.

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