ANIMAL WELFARE AND MEAT QUALITY OF LAMBS SLAUGHTERED IN NORTH PATAGONIA ARGENTINA.

María Zimerman[1*], Ernesto Domingo[2], Gabriela Grigioni[3 4 5], Héctor Taddeo[2] and Priscila Willems[2]

[1] Instituto de Investigación Animal del Chaco Semiárido (IIACS), INTA, Leales, Tucumán, Argentina
[2] Estación Experimental Agropecuaria INTA Bariloche, Río Negro, Argentina
[3] Instituto de Tecnología de Alimentos (ITA) INTA, Morón, Buenos Aires, Argentina.
[4] Consejo Nacional de Investigaciones Científica y Técnicas - CONICET, Buenos Aires, Argentina
[5] Facultad de Agronomía y Ciencias Agroalimentarias, Universidad de Morón, Argentina.

* zimerman.maria@inta.gob.ar

Abstract

The study was carried out in two commercial abattoirs of North Patagonia during lambs slaughter season. 5 batches of 20 lambs were studied in each slaughterhouse to assess the well-being of animals slaughtered in these plants and its effect on meat quality. Blood samples from each animal were taken before slaughter to assess concentration of physiological indicators of stress. Ultimate meat pH was recorded from each carcass and 60 carcasses were selected to evaluate other meat quality traits. The concentration of physiological indicators of stress founded was higher than those reported in a previous study on animals exposed to different pre-slaughter stressor and slaughtered under controlled conditions. Thus, it could conclude that in commercial systems animals are exposed to a variety of stressful conditions and that some synergism among them can occur. Meat quality parameters also differed, being meat of commercial abattoirs of inferior quality. Lairage time was related neither to physiological indicator's levels nor to meat pH values.

Keywords—Meat quality, Lambs, Pre-Slaughter Stress, Commercial abattoirs.

I. INTRODUCTION

Pre-slaughter handling of animals is included in the group of animal-human interaction which generates stress in livestock (1). Among them are long periods of starvation, mixture of different social groups, inappropriate loading and unloading and bad handling at the abattoir. There is evidence that the above mentioned conditions can also affect the process of transformation of muscle in meat, downgrading its quality (2, 3). The aim of the study was to assess, through physiological metabolites, the animal welfare of Merino lambs slaughtered in slaughterhouses of North of the Patagonia Argentina and assess values of meat quality traits of these animals.

II. MATERIALS AND METHODS

In December and January of two consecutive years data was collected in two slaughterhouses (A and B) of North Patagonia (Río Negro Province). Both of them are qualified by the National Service of Food and Agriculture Health (SENASA) to supply meat along the national territory. In each slaughterhouse a total of 5 batches of Merino lambs of approximately 3 months of age were chosen. Each batch of lambs was of the same age and origin and had been transported and handled in the slaughterhouse all together. The time of lairage in holding pens was registered, but information on transportation time could not be obtained. Twenty lambs were selected at random from each batch and were used for further sampling.

While animals were in the holding pens blood samples were collected via jugular venipuncture to determine urea (commercial kit, Wiener, Argentina) and cortisol (ELISA method, kit Diagnostic Systems laboratories, USA).

Muscle pH was measured 24 h *post mortem* (pHu) in *LongissimusDorsis (*LD) muscle with a pHmeter (Testo 230, BA, Argentina) according to the methodology suggested by Garrido et al. (2005) (4). All carcasses (20 per batch) were ordered according to pHu values and 3 groups were formed: high, medium and low pH. Two carcasses were randomly selected from each group. In this way, 60 carcasses were selected, 6 from each batch. Instrumental colour (L*, a* and b*) was measured according to the methodology suggested by Albertí et al. (2005) (5) using a Minolta CR-400 colorimeter (Konica Minolta Sensing, Inc., Bergen, NJ, USA) with D65 illuminantand an 8-mm aperture. Each muscle was allowed to bloom for 30 min at 2 ± 1 °C before colour measurement. Colour variation (ΔE) was calculated as follows:

$$\Delta E = \sqrt{(L^* - L_{ref}^*)^2 + (a^* - a_{ref}^*)^2 + (b^* - b_{ref}^*)^2}$$

were *ref* is a meat sample used as reference. Water holding capacity (WHC) of LD was determined 24 h *post mortem* according to the compression method described by Pla Torres (2005) (6). The *longisimusdorsis (thoracic)* was removed from the 5° to the 13° thoracic vertebrae, vacuum packed and kept at 4°C for three days. Samples were kept at -20°C pending for analysis. Instrumental tenderness was determined with a Warner-Bratzler shear force (WBSF) device (G-R Electric Manufacturing Co., Manhattan, KS 66502, USA). Previously muscles were thawed at 4° for 24 h and cooked in an electric grill until the centre of the samples reached 71 ± 0.5 °C. WBSF was determined following the general guidelines established by AMSA.

A descriptive statistical analysis was performed. Then, means differences between slaughterhouses were evaluated through analysis of variance using PROC MIXED procedure of SAS v.8 statistical package. Factorial Discriminant Analysis (FDA) was done with the purpose of considering jointly all variables, keeping the groups structure defined by batch (PROC CANDISC procedure of SAS).

III. RESULTS AND DISCUSSION

Mean ± standard deviation of lairage time registered was 28.2 ± 16.5 h. The great variability in this value was originated by a batch which was subjected to 62 h of lairage. Others batches were subject to a lairage from 12 to 44 h. Mean values of blood parameters and meat quality traits are shown in Table 1. No significant differences on urea concentration were found between slaughterhouses. The mean urea value found was 0.23 g/L (n=189). This value is greater than the one reported by Zimerman et al. (2013) (7) on lambs fasted 24 h.: 0.19 g/L. The 90% of studied batches show greater values than those reported by these authors. These results would be an indicator of protein catabolism was produced for a long period of fasting (8, 9).

The mean value of cortisol (CORT) found was 13.5 µg/dL (n=155). This value is greater than those reported by Zimerman et al. (2013) (7) on lambs fasted or expose to fear (presence of dogs barking): 9.5 µg/dL. The 90% of studied batches show greater values of CORT than those reported by the above mentioned authors. Barrientos et al. (2006) also reported higher values of CORT in sheep slaughtered in commercial slaughterhouses compared to those slaughtered under experimental conditions. CORT values found in the present study were higher than those found by Tadich et al. (2009) (11), and similar to those reported by Apple et al. (1995) (12) in one of its groups of animals. In the present study no relationship was observed between lairage time and plasma CORT concentration contrary to reported by Tadich et al. (2009) (11) and Knowles et al. (1993) (13).

Table 1. Mean values (standard deviation) with sample sizes in *italics*, of physiological indicators of stress and meat quality traits of lambs slaughtered in two commercial plants.

	Slaughterhouse		P-value
	A	B	
Urea (g/L)	0.23 (0.07) *96*	0.24 (0.05) *93*	0.707
Cortisol (ug/dL)	12.67 (9.67) *60*	13.96 (9.29) *95*	0.751
pHu	5.94 (0.24) *96*	5.76 (0.22) *100*	0.030
L*	35.92 (3.47) *30*	37.81 (3.35) *30*	0.172
a*	17.16 (2.32) *30*	17.68 (1.94) *30*	0.461
b*	6.29 (1.67) *30*	5.23 (1.27) *30*	0.067
WHC (%)	27.7 (5.71) *30*	31.03 (5.39) *30*	0.302
WBSF (N)	21.94 (5.87) *30*	27.34 (6.62) *30*	0.036

Withregard to meat quality traits, there was a significant difference between slaughterhouses on pHu values. In both cases, the values found exceeded those reported by Zimerman et al. (2013) (7) in not stressed lambs, but in one case, values exceed those found by the same authors in feared animals. There was a great variability in pHu values in the meat of animals slaughtered in commercial plants. Therefore animals slaughtered in slaughterhouses produce carcass with heterogeneous pHu values compared with those slaughtered in experimental and controlled conditions. pHu= 6.0 is considered the lower limit to obtain DFD (dark, firm, dry) meat and 21.6% of carcass exceeded this value. This proportion is higher than that found in quality audits of sheep meat chain in Uruguay on 2002 - 2003 and on 2007-2008 (14, 15). Also this proportion exceeds that reported by Thatcher and Plant (1988) (16). It is interesting to know that all batches had a significant proportion of carcass with pHu higher than 6.0 (Fig 1). There was no significant difference on meat colour parameters between slaughterhouses. The values found were lower than those reported by Zimerman et al. (2013) (7) in no

stressed lambs slaughtered under experimental conditions. The values of L*, a* and b* found in this study were similar to those reported in similar age and weight lambs (12, 17, 18, 13). ΔE was calculated between mean colour values obtained in both slaughterhouses and meat colour value obtained on no stressed lambs by Zimerman et al. (2013) (7) as reference. The value obtained was 5.4. ΔE value between 3 and 6 is detectable by the human eye (19, 20). Therefore colour differences between the considered samples are perceptible by the human eye. When comparing meat colour of lambs slaughtered in commercial plants with those obtained from the lambs subjected to fear treatment (7), the ΔE value obtained was 2.10. Thus, differences in meat colour of these groups of samples were not detectable by human eye. No significant differences on WHC were found between slaughterhouses. The mean WHC value found was lower than those reported by Zimerman et al. (2013) (7) on no stressed lambs. Similar values were reported by Vergara et al. (1999) (21) and Beriain et al. (2000) (22). Lower values were reported by Sañudo et al. (1996) (23) and Sañudo et al. (2000) (24) and higher values by Santos-Silva et al. (2003) (18). Significant differences on WBSF were found between slaughterhouses. Values found in this study were similar to those reported by Zimerman et al. (2013) (7) in nostressed lambs. According to Bickerstaffe et al. (1996) (25) the Australian and New Zealand meat industry, the acceptable limit of tenderness in lambs is set in less than 3 kg (29.4 N) value measured with WBSF. 78.3% of carcass from the present study showed lowest WBSF values.

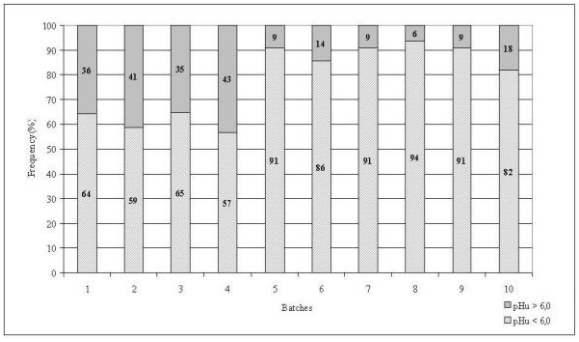

Figure 1.Frequency of carcasses according to pHu grouped by batch (%).

The factorial discriminant analysis (Figure 2) shows differences between batch of both slaughterhouses (Hypothesis test of Lambda de Wilks: $p \leq 0.0001$).

This analysis identifies which of the traits contributed more in the differentiation of the batches. The contribution of each variable to the canonical axes was estimated by Pearson´s correlation coefficients between the original variables and each canonical variable.The first canonical axis separates batch from the two slaughterhouses studied. Even when the correlation coefficients of the traits with this axis were intermediate, the traits that showed the greater values are b* (0.44), pHu (0.38), UREA (0.34) and WBSF with opposite sign (-0.36), all of them were significant ($p<0.05$). Concentration of urea showed a high and significant correlation with axis 2 (0.90), which is the trait that makes batch 5 the most differentiated from the rest. From Fig 2 it is observed that batches of slaughterhouse B are more homogeneous than slaughterhouse A, taken into account the variables considered in this study.

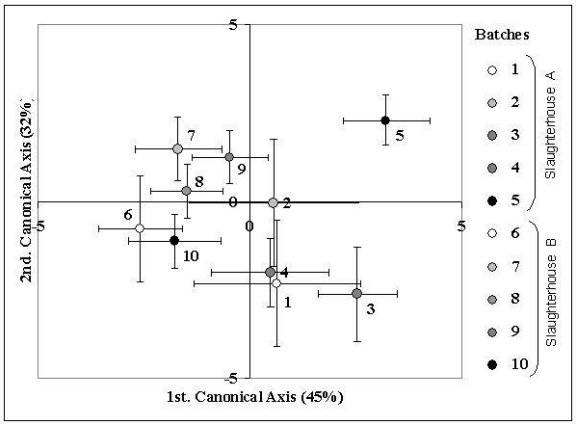

Figure 2. First factorial plane of AFD of lambs slaughtered in commercial plants. The points represent the average of batches (with indication of its standard deviation). Percentages of inertia between groups explained by each axis are expressed between parentheses.

IV. CONCLUSION

Results obtained in the present experiment indicate that conditions of handling of lambs in the slaughterhouses studied, estimated by some blood parameters, are more stressful than those reported elsewhere. Results obtained in the present work also had more variability than those previously obtained under experimental conditions (7). There was a relevant proportion (21.6 %) of carcasses with pHu values higher than 6. Meat from slaughterhouses was darker (lower L*), had less saturation of red and yellow (lower a* and b*) and higher WHC than meat obtained under experimental conditions (7). Nevertheless tenderness didn't differ between commercial and experimental meat.

It should be emphasized the great variability in cortisol values between batches which was not found in a previous study under controlled pre-slaughter stressing conditions (7). Different conditions, other than lairage time, that were not taken into account in this study may be responsible for the great variability of this physiological parameter.

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