Effect of lairage duration on lamb instrumental and sensorial meat quality

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Abstract

The objective of this study was to determine if short (1 h) or long (24 h) lairage at the abattoir has an effect on instrumental meat quality (ultimate meat pH, water holding capacity, colour, raw and cooked texture) and sensory meat quality (trained sensory panel) of commercial lambs. This was part of a combined study where assessment of animal welfare (haematological and physiological parameters) showed that lairage time had a significant effect ($p \leq 0.05$) on stress indicators, but not on meat quality traits. Meat quality parameters were generally lower after short (1 h) than after long (24 h) lairage. There were no significant differences found on instrumental and sensorial meat quality with the exception of yellowness and hue ($p \leq 0.05$) within colour analysis. Trained sensory panellists were unable to identify a significant difference between variables. This suggests that although lairage may affect the product in subtle ways it does not affect meat quality significantly enough to be noted by tasters. Lairage was not found to be necessary to improve meat quality, although from an animal welfare perspective, it is beneficial.

Introduction

Product image is important to commercial industries and pre-slaughter management since transportation can be viewed by consumers while lorries pass through roads and towns. In Spain, young lambs are the most popular meat (Ibañez *et al*., 2002). Adverse practices have been linked to companies which are now trying to counter these reputations with ethical products such as organic meat and free range eggs.

Journey length can be a serious stressor causing exhaustion in animals, depleting muscle glycogen and increasing the incidence of DFD in their meat. The most practical way for animals to recover is to provide a proper lairage time. However, lairage conditions are often more important than the lairage time itself.

It is necessary to analyse the importance of a proper lairage before slaughter as this may provide a beneficial solution to both animals and the producers. Nevertheless, meat quality can only be an indicator of animal welfare if the stressor is very large because a small change in meat quality usually indicates large changes in the animal's welfare.

Material and methods

Forty eight, 100 day-old, male lambs of the "Rasa Aragonesa" breed were analyzed. They had an average live weight of approximately 25 kg (±1.20) and a carcass weight of 11.7 kg (±1.03). Lairage treatments were: long (24h) and short (1h). Within each treatment, twelve animals and two replicates were analyzed. The animals were taken directly from the farm to "Mercazaragoza" abbatoir (EU accredited), which is approximately a 1 hour journey away. The loading density was within EU specifications at 137 kilos/m². All loading, transportation and unloading was done commercially but monitored by the project investigators. All animals were kept in pens designed especially for lairage, with cemented walls and non-sliding designed floors. The pens were equipped with fans to circulate air and improve room temperature. Water was freely available but there was no access to feed. The density of animals in each pen allowed for free movement and natural resting behaviour.

Post slaughter, carcasses were stored in cold rooms at 4º C for 24 hours. Carcasses were weighed while warm and again at 24 hours post mortem when the extent of haematomas on the carcass was also estimated visually using the scale proposed by Honkavaara et al., (1999) from 0 (none) to 3 (high) bruising level. To determine the pH_{ult} of the *Longissimus dorsi* muscle, a portable pH meter (fitted with a penetration electrode 52-00 from Crison) was used. Without breaking the cold chain, carcasses were transported to the Product Quality Laboratory at the Faculty of Veterinary medicine (Zaragoza). The *Longissimus dorsi* muscle was dissected out using Colomer - Rocher *et al.* (1988) quartering technique. Once dissected, the muscle was divided into two equal portions, one used for texture analyses and the other for sensorial meat quality testing. These portions were individually vacuum-packed and matured for a total of 3 days (24 h in the abattoir and

48 h at 4º C in the laboratory). Once matured, the samples were frozen and stored at - 20º C until the instrumental and sensorial evaluations were made.

For colour analysis, a cross sectional cut was made in the *Longissimus dorsi* and refrigerated for an hour so to oxygenate the cut surface. The external colour was analyzed using a reflectometer-colorimeter Minolta. The following variables were evaluated by CIE-Lab: L*(lightness), a* (redness), b*(yellowness), hue (H *) and chroma (C *). Water holding capacity was determined by "method of pressure" according to Grau Hamm's (1953) technique.

For instrumental texture, the packaged *Longissimus dorsi* loin was defrosted for 24h at 4º C. Once defrosted the sample was halved perpendicular to fibre direction, one part destined for the cooked meat texture analysis (Warner-Bratzler shear test) and the other for determining fresh meat texture (Compression). The loin for the W-B test was vacuum-packed and placed in a Maria bath (75º C). After that, samples were cooled for 2h and then cut into 1 cm^2 pieces. Analyses were made using a universal test machine (INSTRON series 4301). Measurements were recorded for the maximum force applied, point of inelastic deformation and instrumental force necessary to break the sample. Compression analysis of raw meat was prepared in the same manner, with the variables measured being the effort required when compressing to 100%, 80% and 20% force.

For the sensorial analysis nine trained individuals were used as tasters. Samples were analyzed in cabins designed specifically for sensorial analysis. There were four tasting sessions in which the nine panellists analyzed six plates of two samples each per session. The vacuum-packed meat was defrosted in a fridge for 24h before each tasting session. The loin was then cooked in a double surface grill (SAMMIC P8D-2) until the internal temperature reached 70 ºC. When cooked, the meat was cut horizontally into nine separate pieces. Each piece was wrapped individually in a small square of aluminium foil and then presented to the panellists under a red light to mask meat colour. Each treatment was analyzed and compared 24 times by each taster (216 judgments in total) with the panellists using a semi-structured scale (10 cm) to describe: lamb odour, fat odour, wool odour, tenderness, juiciness, fibrousity, lamb flavour, fat flavour, liver flavour, acid flavour and overall liking. Zero represents samples with little odour and flavour intensity, bad texture and low overall appreciation. Ten represents samples with high flavour and odour intensity, good texture and high overall appreciation.

The results were analysed by least mean square technique. A factorial model was applied that included the fixed effect of the lairage time and the analyses were done using the GLM procedure in SAS. For analysis of meat traits carcass weight was added as a covariate.

Results and discussion

There were no significant differences in pH_{ult}, and levels were inside the normal average for lambs: 5.68 ($\pm$0.01) for 24h lairage and 5.65($\pm$0.01) for 1h one. There was no significance in bruising levels due to lairage time: 0.05 ($\pm$0.005) long lairage and 0.10 ($\pm$0.005) short lairage. No significance was found between WHC of lairaged and non lairaged meat. Values for 1h lairage were 18.48 ($\pm$0.49) and 19.54 ($\pm$0.49) for 24h lairage.

Table 1 shows the effect of lairage on colour. A significant affect of lairage on hue and redness was found, with lairaged meat having a lower hue and lower b*. Differences in lightness were not significant which disagrees with Liste et al. (In press) but agrees with Grigor et al. (2004).

Table 1. Least square means (±s.e.) and significance of lairage on colour analyzed variables

Colour	Long Lairage (24h)	Short Lairage (1h)	Sig.
L	39.40 ($\pm$0.37)	38.58 ($\pm$0.37)	NS
a*	11.45 ($\pm$0.23)	11.31 ($\pm$0.23)	NS
b*	7.14 ($\pm$0.18)	6.32 ($\pm$0.18)	*
Chroma	13.52 ($\pm$0.24)	12.98 ($\pm$0.24)	NS
Hue	32.00 ($\pm$0.72)	29.50 ($\pm$0.72)	*

NS: no significance, * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$.

Texture results are shown in Table 2. Compression at 20% showed a significant difference between treatments ($p \leq 0.05$) suggesting that lairaged meat may be less tender than non-lairaged meat. Results did not show any significant difference between W-B measurements.

Table 2. Least square means (±s.e.) and significance of the effect of lairage on texture variables

Warner Bratzler	Long Lairage (24h)	Short Lairage (1h)	Sig.
Maximum stress (kg/cm²)	3.87 (±0.23)	3.82 (±0.23)	NS
Toughness (kg/cm²)	1.85 (±0.11)	1.92 (±0.11)	NS
Point of inelastic deformation (kp)	0.21 (±0.01)	0.22 (±0.01)	NS
Compression			
Compression at 20% (N/cm²)	8.72 (±0.27)	8.03 (±0.27)	*
Compression at 80% (N/cm²)	34.47 (±1.36)	34.46 (±1.36)	NS
Maximum Load (N/cm²)	41.98 (±1.34)	43.97 (±1.34)	NS

NS: no significance, * p≤0.05, ** p≤0.01, *** p≤0.001.

Table 3 shows results of the sensorial analysis. Trained sensory panellists were unable to identify a difference between variables. This suggests that although lairage may affect the product in subtle ways, it does not affect meat quality significantly enough to be noted by tasters.

Table 3. Least square means (±s.e.) and significance of the effect of lairage on sensorial meat quality traits

Sensorial Meat Quality	Long Lairage (24h)	Short Lairage (1h)	Significance
Lamb Odour	4.77 (±0.12)	4.78 (±0.13)	NS
Fat Odour	3.01 (±0.09)	2.97 (±0.09)	NS
Wool Odour	2.42 (±0.16)	2.39 (±0.17)	NS
Tenderness	4.88 (±0.16)	4.80 (±0.17)	NS
Juiciness	4.42 (±0.09)	4.43 (±0.09)	NS
Fibrousity	4.66 (±0.12)	4.65 (±0.12)	NS
Lamb Flavour	5.72 (±0.87)	5.52 (±0.07)	NS
Fat flavour	4.20 (±0.08)	4.18 (±0.80)	NS
Liver Flavour	2.25 (±0.07)	2.16 (±0.07)	NS
Acid Flavour	3.22 (±0.08)	3.14 (±0.08)	NS
Overall Liking	3.84 (±0.18)	4.07 (±0.18)	NS

NS: no significance, * p≤0.05, ** p≤0.01, *** p≤0.001.

Conclusions

Results suggest that a lairage of twenty four hours may be too long and examining more time lengths may be worthy. In conclusion, lairage is not necessary for improving meat quality of commercial lambs in Spain, making lairage an ethical choice as opposed to an economical one.

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