PE8.07 Effect of the CO2 concentration at stunning and the time exposure on suckling and light lamb meat lipid oxidation 39.00

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Abstract—The effect of the CO2 concentration and the exposure time at stunning [80% CO2 for 90 s (G1); 90% CO2 for 90 s (G2); 90% CO2 for 60 s (G3); 80% CO2 for 60 s (G4)] was studied for lipid oxidation (LO) in Manchega breed suckling (12.8 kg) and light (25.0 kg) lamb meat, at 24 h and 7 d post-mortem. An electrically stunned control group (G5) was assessed. In general similar values were found for LO in both types of lamb. Type of stunning caused significant differences (P<0.01) at 24 h in LO but theses differences disappeared at 7d post-slaughter. In addition a significant interaction of type of stunning x type of lamb was found (P<0.01 and P<0.05 for 24 h and 7 d respectively). LO increased (P<0.001) in all meat samples with ageing time.

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Index Terms—lipid oxidation, meat, lamb, gas stunning.

I. INTRODUCTION

FACTORS related directly to handling prior to slaughter, such as transport or the type of stunning, may affect meat quality through stress, since this decreases muscular glycogen reserves and may lead to high ultimate pH in meat [1]. Stunning of lambs using CO2 has been considered an alternative method to electrical stunning due to positive results on meat quality [2] and on lipid oxidation (LO) [3]. However, further studies are necessary to ascertain both the correct exposure time for stunning and the concentration of this gas, in order to provide more data on the shelf-life of lamb meat with regard to lipid oxidation. The aim of this study was to evaluate in Manchega breed suckling and light lambs the effects of the gas-stunning method using different CO2 concentrations and exposure times on the lipid oxidation level, at 24 h and 7 d post-mortem.

II. .MATERIALS AND METHODS

A. Animals and experimental design 99 Spanish Manchega breed suckling (n=49) and light (n=50) male lambs were used for this study. Animals were slaughtered at 12.80 ± 0.20 kg live weight (30 days old) and at 25± 0.14 kg live weight (70 days old) respectively.

Both types of lambs were distributed into five groups (n=10) according to the type of stunning:

-Four groups were stunned with gas using different CO2 concentrations and exposure times (G1: 80% for 90s; G2: 90% for 90s; G3: 90% for 60s; G4: 80% for 60s; volume in air), using a gondola dip-lift system (G van Wijnsberghe & Co n.v. Veurne, Belgium) which is usually used for stunning pigs (3 m long x 1,5 m wide x 1 m high).

-A control group (G5) was electrically stunned at 110 V, 50 Hz for 5 s (plate electrodes applied on both sides of the head, behind the ears; Electronarcosis Panel, MAC-01, Bernard, S.L.). All carcasses were chilled at 4º C for 24 h in a conventional chiller. After this period, the Longissimus dorsi from both sides of the carcasses was removed and two portions were obtained for this experiment. One portion was used to determine

lipid oxidation level (LO) at 24 h. Another sample was packed in a clear tray (LINPAC, Plastic, West Yorkshire) with an oxygen permeability rate of 3.2 cm3 m-2 day-1 at 1 atm and 23º C, and covered with a film (having an oxygen permeability of 500 cm3 m-2 day-1 at 1 atm and 25º C) and stored at 2ºC in dark and LO was analysed after 7 d post-mortem.

B. Lipid Oxidation Analysis

Malonaldehyde (MDA) content was assessed according to [4] in all meat samples, using a 5 g sample which then was homogenized with 25 ml of distilled water in a Ultraturrax T18 basic (IKA Works, Inc., USA) homogenizer for 2 minutes at 10,000 rpm. Twenty-five ml of 10% trichloroacetic acid (TCA) was added and the homogenate was suction-filtered using Whatman No. 1 filter paper. Four ml of the clear filtrate was added to 1 ml of 0.8% thiobarbituric acid (TBA) reagent and incubated at 80ºC for 90 minutes.

Finally, the absorbance at 532 nm was read with a Helios alfa spectrophotometer (THERMO, Electron Corporation, England). Results were expressed as mg MDA kg-1 of meat.

C. Statistics analysis

Statistical analyses were performed using Statistical Package SPSS 14.0 version (SPSS Inc., Chicago, USA, 2005). A GLM procedure was carried out to determine the effect of the stunning methods (G1/G2/G3/G4/G5) and the type of lamb (suckling vs light) at 24 h and at 7 days post-mortem on LO. A Tukey's test at a significance level of $P<0.05$ was carried out to test for differences between the treatment pairs of groups. For each group the effect of time (24 h vs 7 d post-mortem) on LO was calculated using an analysis of variance (ANOVA).

III. RESULTS AND DISCUSSION

Table 1 shows the LO levels (means ± e.s) at 24 h and 7d post-mortem in each group of stunning and in both types of lamb and the differences between pairs of groups (Tukey´s test). At 24 h post mortem the highest LO was found in the samples of electrically stunned light lambs (0.64±0.02mg malondihaldehyde/kg-1). No differences were found among the rest of the groups. After 7 d post-mortem LO values increased significantly ($P<0.001$) in agreement with others authors in lamb [3], pork [5], beef [6]. In addition no group (type of lamb-stunning group) reached the value established by other authors [7] as a detectable concentration for humans, 5 mg malondialdehyde kg-1 meat. However this last value was much higher than the indicated to detect oxidised flavours by others authors [8] in lamb (TBARS above 2) or [9] in beef (TBARS range of 0.6-2.0). GLM procedure (Table 2) showed no differences between suckling and light lamb. A significant interaction Type of stunning x Type of lamb ($P<0.01$ at 24 h and $P<0.05$ at 7 d post-mortem) for LO was found in this experiment, thus indicating the effect of type stunning ($P<0.01$ at 24h) on LO depending on the slaughter weight of lamb. At 24 h similar values on LO level were found for the suckling lamb stunning groups. However in light lamb the electrical stunning caused the highest LO. At 7d post-mortem in younger lamb the highest values were found in samples of animals stunned with G4. Curiously in the older lambs and at this same ageing time, LO was lower in groups stunned using 80% CO2 (during 90 or 60 s; G1 and G4 respectively).

IV. CONCLUSION

According to the results of the present study, we can conclude that (1) the type of stunning affected LO but with results different depending on the slaughter weight of the lamb. (2) In general LO levels were similar in both type of lamb. (3) Even though that the ageing time increased LO none of the gas stunning methods reached levels extremely high to detect oxidised flavours.

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REFERENCES

[1] Devine, C.E.; Graafhuis, A.E.; Muir, P.D. & Chrystall, B.B. (1993). The effect of growth rate and ultimate pH on meat quality of lambs. Meat Science, 35, 63-77.

[2] Vergara, H.; Linares, M. B.; Berruga, M. I. & Gallego, L. (2005). Meat quality in suckling lambs: effect of pre-slaughter handling. Meat Science, 69, 473-478.

[3] Linares, M.B.; Berruga, M.I.; Bórnez, R. & Vergara, H. (2007). Lipid oxidation in lamb meat: Effect of weight,

handling previous slaughter and modified atmospheres. Meat Science, 76, 715-720

[4] Tarladgis, B.G.; Pearson A.M. & Dugan R. (1964). Chemistry of the 2-thiobarbituric test for determination of oxidative rancidity in foods II. Formation of the TBA-malonaldehyde complex without acid-heat treatment, Journal of Food Science and Agriculture 5, 602–604.

[5] Martínez, L.; Djenane, D.; Cilla, I.; Beltrán, J.A. & Roncalés, P. (2005). Effect of differrent concentrations of carbon dioxide and low concentration of carbon monoxide on the shelf-life of fresh pork sausages packaged in modified atmosphere. Meat Science, 71, 563-570.

[6] Luño, M.; Roncalés, P.; Djenane, D. & Beltrán, J.A. (2000). Beef shelf-life in low O2 and high CO2 atmospheres containing different low CO concentrations. Meat Science, 55, 413-419.

[7] Insausti, K.; Beriain, M.J.; Purroy, A.; Alberti, P.; Gorraiz, C. & Alzueta, M.J. (2001). Shelf life of beef from local Spanish cattle breeds stored under modified atmosphere. Meat Science, 57, 273-281.

[8] Camo, J; Beltrán, J.A. & Roncales, P. (2008). Extension of the display life of lamb with an antioxidant active packaging. Meat Science, 80, 1086-1091.

[9] Greene, B.E., & Cumuze, T.H. (1981). Relationships between TBA-numbers and inexperienced panellist assessment of oxidized flavor in cooked beef. Journal of Food Science, 47,52-54.58.

Table 1. Means ± e.s. for lipid oxidation (mg malonaldehyde/kg^{-1} meat) in suckling (S) and light (L) lambs stunned with different methods

Time post-mortem	G1		G2		G3		G4		G5	
	S	L	S	L	SL	L	S	L	S	L
24 h	0.37±0.08	0.30±0.05^{d}	0.33±0.07	0.33±0.05^{d}	0.34±0.07	0.24±0.08^{d}	0.14±0.02^{g}	0.38±0.07^{dh}	0.34±0.08^{g}	0.64±0.02^{eh}
7 days	1.33±0.18^{a}	1.01±0.26^{d}	1.40±0.16^{a}	1.62±0.21^{de}	1.33±0.15^{ag}	1.82±0.11^{eh}	2.13±0.21^{bh}	1.30±0.15^{deg}	1.45±0.17^{ab}	1.62±0.13^{de}
ANOVA	***	**	***	***	***	***	***	***	***	***

Gas Stunning (G1: 80% CO_2 for 90s; G2: 90% CO_2 for 90s; G3: 90% CO_2 for 60s; G4: 80% CO_2 for 60s)
G5: Electrical stunning
[a,b] Significant differences ($P < 0.05$) between suckling lambs stunned with different stunning method
[d,e] Significant differences ($P < 0.05$) between light lambs stunned with different stunning method
[g,h] Significant differences ($P < 0.05$) between S and L lambs stunned with the same method
ANOVA: Effect of ageing time; [**,***] Indicates significant levels of 0.01 and 0.001 respectively.

Table 2. Effect of TL, TS and its interaction: Results of GLM procedure

Time post-mortem	GLM procedure		
	TL	TS	TS x TL
24 h	NS	**	**
7 days	NS	NS	*

TL: Type of lamb (Suckling *vs* Light)
TS: Type of stunning (G1/G2/G3/G4/G5)
[**, *] Indicate significance levels at 0.01 and 0.05 respectively;
NS: not significant