EFFECT OF REFRIGERATION TEMPERATURE AND CARCASS WEIGHT ON LAMB CARCASS AND MEAT QUALITY PARAMETHERS

E. Muela*, J.A. Beltrán, M.M. Campo, C. Sañudo
Dept. Animal Production and Food Science, University of Zaragoza, 50013-Zaragoza, Spain
*462065@vetez.unizar.es

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Introduction

The self-life of meat has always been of human concern since it is a perishable product. Within conservation systems, the use of low temperatures has been widely used. However, in spite of known general facts of refrigeration, the effects of small variations in any of its parameters have not been largely studied in all species. Within the same cooling conditions rate at commercial levels, there are several types of animals at the same time, which can be affected in different ways by the environment. Besides the complex marketing of lamb demands a deeper knowledge in this subject, in order to increase the quality of a product that is, commonly, highly considered by consumers. The aim of this study is to determinate the influence of refrigeration temperature on instrumental meat quality of commercial lamb at two weights.

Material and Methods

The assessment comprised 60 lamb carcasses, divided in 3 batches (1 per week) of 20 carcasses. Each batch was composed of two hot carcass weights (HCW), with 10 animals per HCW (<10,5 kg, >12,5 kg). The experiment took place in the installations of "Pastores Group", in an independent cold storage room. The relative humidity (RH) and Temperature (T) were monitored with four data logger *Testo 175-H2*, placed on the walls of the cold storage room at the same height than the carcasses and programmed to measure each 5 min from the entrance of the carcasses until 90h post slaughtering. The average RH was 92% and the three average T tested were 0-2, 2-4 and 4-6º C. Carcasses were individually weighed immediately after slaughter (HCW) and after 18, 42, 66 y 90h (CCW) with a platform table scale (± 5 g). With both values it was calculated the **weight losses** (% WL= [(HCW - CCW)/ HCW] * 100). **pH** was measured on a incision in the left LD at the level of the 8th thoracic vertebra at 18, 42 and 96h post slaughter with a portable pH-meter with a penetration electrode. 90h post slaughter, carcasses were transported to the meat quality laboratory of the Veterinary Faculty of Zaragoza, where the muscle *Longissimus dorsi* (LD) was dissected from the left carcass and sliced according to the analyses requirements. **Colour measures** were taken following the CIE-L*a*b* methodology (1986) on the cut surface of the 13th thoracic vertebra in the LD after 1h of blooming. Samples were kept in expanded polyestirene trays covered with air permeable film and under refrigeration conditions. For **texture analysis**, the muscle from 9 to 13th thoracic vertebra was vacuum packaged (with 96h of ageing), frozen and kept at -18ºC until analyzed. After thawing at 4º C for 24h, texture was measured with an *Instron series 4301*, first by compression test in raw meat (compression at 20% and 80%) and by the Warner-Braztler methodology in cooked meat (shear force). **Lipid oxidation** samples were taken from 6 to 8th thoracic vertebra and vacuum packaged, frozen and kept at -18ºC until analyzed. After thawing at 4º C for 24h, lipid oxidation was measured according to TBARS (Thiobarbituric acid-reactive substances) methodology (Pfalzgraf et al., 1995).
Data were analysed with SPSS (14.0) with a General Linear Model Procedures. Mean comparisons were assessed by the Duncan test.

Results and Discussion

No interaction between T and HCW was found. The effect of T on **WL**, showed lower values (1.95-2.19) at 90h than those commonly applied in the industry (2-4%) after 24h. There were significant differences between treatments at any interval, with higher values at 0-4º C than at 4-6º C from 42h onwards, due to the phenomenon of heat transfer produced between carcass surface/cold air, wich is bigger when environmental T is lower. Moisture and heat transport are strongly coupled at the surface of the food, each influencing the other (Pham and Kurari, 1999). HCW effect showed that carcasses with higher WL were the lighter ones, because, proportionally, they lost more weight. HCW had a significant effect after 18h under refrigeration conditions, which could indicate that it would be better to adeccuate T refrigeration conditions to HCW.
Neither T nor HCW affected significantly over **pH** values at short periods, but they did on ultimate pH (96h), where it was observed that as refrigeration T was lower, pH value was higher, probably due to a higher enzymatic action with higher T. Also, lighter carcasses showed higher pH value, although within normal range.
The effect of T on **colour parameters** was significant for luminosity (L*), a* (red index), b* (yellow index) and C* (chroma). It was observed that higher refrigeration T was associated with lighter meat, probably related to a lower pH. It was also related to higher hue (h*) and C* values. A possible explanation is that lower T is less detrimental to the myoglobin pigment and this causes the myoglobin structure to be open and scatter light,

creating a pale colored product (Lawrie, 1998). On the other hand, HCW only had a significant effect on h* and C*, with lighter carcasses showing higher values.
On **texture analysis**, there was neither T nor HCW effect over compression test on raw meat. There was only a low significance in Warner-Braztler test, where carcasses exposed at medium T were tougher than the others.
Finally, **TBARs** values were not affected by T effect. HCW had a low significance, being more oxidized the heaviest carcasses, although parameters observed were within the normal average values described for lamb.

Table 1: Effect of refrigeration temperature and hot carcass weight on carcass and meat quality parameters (means and significance values)

Effects/ Variables		Temperature				Hot Carcass Weight		
		0-2º C	*2-4º C*	*4-6º C*		*<10,5kg*	*>12,5kg*	
		n=20	*n=20*	*n=20*		*n=10*	*n=10*	
Weight losses (%)	18 h	1.11a	1.38b	1.09a	***	1.22	1.17	ns
	42 h	1.63b	1.80b	1.37a	***	1.72	1.47	**
	66 h	1.99b	1.91b	1.64a	***	1.98	1.72	**
	90 h	2.05b	2.19c	1.95a	***	2.39	2.04	***
pH	18 h	5.88	5.90	5.90	ns	5.90	5.88	ns
	42 h	5.73b	5.66a	5.70ab	t	5.68	5.71	ns
	96 h	5.58b	5.54ab	5.48a	**	5.56	5.51	**
Colour measures	Luminosity (L*)	31.50a	38.08b	40.27c	***	36.50	36.74	ns
	Red index (a*)	12.62b	10.53a	11.19a	**	11.48	11.41	ns
	Yellow index (b*)	13.60c	7.42a	9.50b	***	10.09	10.26	ns
	Hue (h*)	38.77a	41.00ab	43.72b	t	43.51	38.82	**
	Chroma (C*)	13.90a	1.89b	16.46b	**	16.68	14.15	***
Texture analysis	Compres. 20%	6.72	5.08	5.64	ns	5.93	5.69	ns
	Compres. 80%	36.64	34.59	38.44	ns	39.66	33.45	t
	Shear force	1.51a	1.96b	1.45a	*	1.60	1.68	ns
TBARS (mg MA/kg)	-	0.14	0.13	0.14	ns	0.13	0.14	*

a,b,c: different letters in the same line indicate significant differences. ns: no significance; t: p<0,1; *(p<0,05); ** (p<0,01); *** (p<0,001).
TBARS: Thiobarbituric acid-reactive substances. MA: malonaldehide.

Conclusions
No interaction between temperature and hot carcass weight was found. Refrigeration temperature had a significant effect on weight losses and meat colour, having higher weight losses as temperature decreased. The effect of temperature on final pH and meat colour was also significant. On the other hand, carcass <10.5 kg showed higher weight losses, pH and hue and chroma values. It would be desireable to increase, within cooling conditions, refrigeration temperatures to minimize weight losses and to adeccuate temperature refrigeration conditions to hot carcass weight.

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References
1. CIE (1986). Colorimetry, 2nd ed., CIE Publications No. 15.2. Commission Internationale de l'Eclairage: Vienna.
2. Lawrie, R.A (1998). Lawrie's meat science, pp. 216, 6th ed., Woodhead, Ltd, Cambridge, England.
3. Pham, Q.T., and Kurari, N. (1999). A computationally efficient technique for calculating simultaneous heat and mass transfer during food chilling. In Proceedings of 20th international congress of refrigeration, Sydney, Australia.
4. Pfalzgraf, A., Frigg, M. and Steinhart, H. (1995). α tocopherol contents in lipid oxidation in pork muscle and adipose tissue. Journal of Agriculture and Food Chemistry, vol. 4, pp. 1339-1342.