OXIDATIVE AND COLOR CHANGES IN M. *LONGISSIMUS DORSI* FROM THREE LINES OF FREE-RANGE REARED IBERIAN PIGS SLAUGHTERED AT 90KG LIVE WEIGHT AND COMMERCIAL PIGS UNDER REFRIGERATED STORAGE

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BACKGROUND

Meat color influences consumer´s election and acceptance but also reflects the quality expectation of meat (Bredahl et al., 1998).

Lipid oxidation, as microbial alteration, is one of the most important causes of meat deterioration as it modifies sensory and nutritional characteristics of meat, causing a yellow coloration of fat, loss of water, texture alteration and off-flavours appearance (Gray et al., 1996).

At present, there is an increasing demand of high quality products named as 'biological', 'organic' or 'natural', on account of the peculiar methods of their production and the high quality of the foodstuff obtained from them (Sundrum, 2001).

The Iberian pigs and their extensive production system in the Southwest of the Iberian peninsula, represent a clear example of an organic and environmentally friendly production. Meat from free-range reared Iberian pigs is characterised by a high content of intramuscular fat, monounsaturated fatty acids (Cava et al., 1997), myoglobin pigments and oxidative fibres (Andrés et al., 2000).

The are no previous studies about the influence of this rustic livestock system on lipid stability and color changes of meat under refrigerated storage.

OBJECTIVES

The aim of this work was to study oxidative and color changes in free-range reared Iberian pigs and commercial pigs *longissimus dorsi* muscle during refrigerated storage in order to compare both 'organic' production and rustic pig breeds *versus* traditional livestock and commercial pig breeds production.

METHODS

21 Iberian pigs from three different lines, Lampiño (**LAM** ; n=7), Retinto (**RET**; n=7) & Torbiscal (**TOR**; n=7) were slaughtered at 90 Kg live weight and samples from the *longissimus dorsi* muscle were taken from the carcasses.

The commercial *longissimus dorsi* (**COM**; n=5) were procured from a local slaughterhouse the same day.

The day after slaughter, the muscle chops were packed individually and placed under refrigerated storage during 10 days. Muscle samples were analysed at days 0 (fresh meat), 1,3, 7 & 10.

Instrumental color (Cie L* a* b*; Cie, 1976) was measured in triplicate across the cut surface using a Minolta Chromameter CR-300 (Minolta Camera Corp., Meter Division, Ramsey, NJ). Chroma (C) and Hue angle (h°) values were obtained by using the following equations: $C= (a^{*2} + b^{*2})^{0.5}$ & $H^o= \text{arctg } b^*/a^*$.

Thiobarbituric acid reactive substances (TBARS) were evaluated using a method adapted from that of Salih et al., (1987). Determination of phospholipid content was carried out with the method described by Barlett (1959). Data were analysed using statistical models from SPSS 10.0 (SPSS, 1999).

RESULTS & DISCUSSION

The COM *longissimus dorsi* presented a higher elevation in TBARS content and an upper final oxidation value ($p<0.05$) than Iberian *longissimus dorsi* muscles (figure 1). Thus, the phospholipid content in COM *longissimus dorsi* muscles reduced to the 60% of the initial value during refrigerated storage, while the Iberian *longissimus dorsi* kept between 86 and 98% of their initial phospholipid content (figure 2). The evolution of color measurement values during refrigerated storage are given in table 1. The data obtained suggest that Iberian *longissimus dorsi* had the darkest overall, reddest color and diverged the least from the true red axis, before, during, and after the refrigerated storage ($p<0.05$). Redness value increased during the first 24 hours of storage in the four groups, then fell gradually over time until the lowest value at day 10. Yellowness and color saturation (chroma) trends resulted similar to that described for redness. The m. *longissimus dorsi* samples tended to be less redness and more grey as time increased. This typical evolution was described in previous papers (i.e. Zhu & Brewer;1998). The increase of a* and chroma could be a reflection of the oxygen consumption rate (OCR) decline few hours after slaughter as it was proposed by Ledward (1991). The oxygen diffuses to a higher depth in meat what induces a color improvement (Ledward, 1991) measured in this work as an increase of redness and chroma values. Redness evolution as analysed by the calculated trend lines: LAM: $-0.27x+12.61$, R^2: 0.65; RET: $-0.14x + 11.80$, R^2: 0.38; TOR: $-0.15x+ 9.87$, R^2: 0.77; COM: $-0.19x + 7.6847$, R^2: 0.64), suggest a faster color deterioration in m. *longissimus dorsi* from the commercial pig and the 'Lampiño' Iberian line. The metmyoglobin accumulation and meat color deterioration largely depend of lipid oxidation due to the causality relationship established between both degradation processes (Mohanan et al., 1994; O´Sullivan et al., 2002). In fact, the amount of TBARS significantly increased with time during refrigerated storage (Figure 1; $p<0.05$) as meat color deteriorated (increase of hue angle & decrease of redness). Natural antioxidants as tocopherols, can be obtained by pigs from pasture grazing feed (Cava et al., 2000), and its presence in muscle fibres membranes seems to protect the polyunsaturated fatty acids placed in them (Alasnier et al., 2000) and myoglobin pigment (O´Sullivan et al., 2002) from oxidation phenomena. The 'organic' production of the Iberian pigs could influence the oxidative and color stability of meat as it has been described in previous papers over pigs reared in similar conditions (p.e. Nilzén et al., 2001). In spite of that, LAM *longissimus dorsi* presented a higher color deterioration rate, probably due to its higher content of prooxidants factors (heme iron and myoglobin content, data not shown).

Lightness decline was faster ($p<0.05$) in COM *longissimus dorsi* (COM: $-1..31x + 57.99$, R^2: 0..94; LAM: $-0.39x + 48.59$, R^2: 0.46; RET: $-0..38x + 46.56$, R^2: 0.28; TOR: $-0.4115x + 47.64$; R^2: 0.33) what could affect the sensorial perception of the already deteriorated meat.

PERTINENT LITERATURE

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Table 1- Cie L, a* ,b*, Chroma and Hue angle of the *longissimus dorsi* muscle from three lines of free-range Iberian pigs and commercial pig. Evolution during 10 days of refrigerated storage. (mean ± standard error).

	'LAMPIÑO' (n=7)	'RETINTO' (n=7)	'TORBISCAL' (n=7)	COMMERCIAL (n=5)	p
L*					
DAY0	46.5^{b} ± 0.94	43.40^{b} ± 0.33	45.03^{b} ± 1.42	56.77^{a} ± 1.32	**0.000**
DAY1	48.92^{b} ± 0.84	47.82^{b} ± 0.36	47.96^{b} ± 1.24	56.19^{a} ± 1.21	**0.000**
DAY3	48.66^{b} ± 1.02	46.71^{b} ± 0.48	47.75^{b} ± 1.18	56.53^{a} ± 1.06	**0.000**
DAY7	47.75^{a} ± 1.16	46.48a ± 0.50	47.69a ± 1.34	48.53a ± 1.10	**0.632**
DAY10	42.99^{ab} ± 0.98	40.38^{b} ± 0.94	40.98^{b} ± 0.81	44.33^{a} ± 0.52	**0.021**
a*					
DAY0	11.40^{a} ± 0.43	10.62^{a} ± 0.82	9.48^{a} ± 0.27	7.24^{b} ± 0.16	**0.000**
DAY1	13.22^{a} ± 0.47	12.60^{a} ± 0.56	9.43^{b} ± 0.38	8.24^{b} ± 0.09	**0.000**
DAY3	12.20^{a} ± 0.46	11.96^{a} ± 0.62	9.98^{ab} ± 0.31	7.09^{b} ± 0.26	**0.000**
DAY7	11.17^{a} ± 0.39	10.41^{a} ± 0.78	8.60^{ab} ± 0.32	5.77^{b} ± 0.11	**0.000**
DAY10	9.24^{ab} ± 0.47	10.22^{a} ± 0.68	8.21^{b} ± 0.36	6.26^{c} ± 0.50	**0.000**
b*					
DAY0	4.57^{ab} ± 0.29	3.52^{b} ± 0.74	4.70^{ab} ± 0.29	6.30^{a} ± 0.46	**0.009**
DAY1	8.21^{a} ± 0.32	8.21^{a} ± 0.31	6.51^{b} ± 0.23	6.82^{b} ± 0.18	**0.000**
DAY3	8.61^{a} ± 0.33	8.69^{a} ± 0.29	8.00^{a} ± 0.17	7.07^{b} ± 0.15	**0.001**
DAY7	8.38^{a} ± 0.37	8.29^{a} ± 0.53	7.75^{a} ± 0.23	5.02^{b} ± 0.22	**0.000**
DAY10	5.31^{a} ± 0.73	5.79^{a} ± 0.61	6.01^{a} ± 0.40	5.90^{a} ± 0.32	**0.823**
Chroma					
DAY0	12.31^{a} ± 0.29	11.21^{ab} ± 0.48	10.71^{ab} ± 1.05	9.63^{b} ± 0.36	**0.075**
DAY1	15.57^{a} ± 0.41	15.05^{a} ± 0.54	11.47^{b} ± 0.60	10.72^{b} ± 0.17	**0.000**
DAY3	14.94^{a} ± 0.31	14.79^{a} ± 0.52	12.82^{b} ± 0.62	10.03^{c} ± 0.21	**0.000**
DAY7	13.97^{a} ± 0.36	13.33^{ab} ± 0.49	11.63^{b} ± 0.83	7.68^{c} ± 0.16	**0.000**
DAY10	10.76^{ab} ± 0.39	11.90^{a} ± 0.69	10.31^{ab} ± 0.74	8.65^{b} ± 0.52	**0.016**
Hue					
DAY0	21.80^{bc} ± 0.94	18.18^{c} ± 1.79	26.57^{b} ± 1.28	40.63^{a} ± 1.96	**0.000**
DAY1	31.89^{b} ± 0.66	33.11^{b} ± 1.16	34.82^{b} ± 0.62	39.62^{a} ± 0.58	**0.000**
DAY3	35.25^{c} ± 0.79	36.03^{bc} ± 1.32	39.08^{b} ± 0.56	44.99^{a} ± 1.19	**0.000**
DAY7	36.91^{a} ± 1.01	38.57^{a} ± 2.29	42.44^{a} ± 0.60	40.93^{a} ± 1.41	**0.060**
DAY10	30.16^{b} ± 2.88	28.95^{b} ± 3.12	36.82^{ab} ± 1.93	43.88^{a} ± 1.84	**0.003**

Means with different superscript differ significantly.

Figure 1. Evolution of TBA-RS (expressed as mg MDA/kg muscle in defatted dry basis) of m. *longissimus dorsi* from three free-range reared Iberian pig sires (*'lampiño'*, *'retinto'* and *'torbiscal'*) and commercial pig under refrigerated storage at +4ºC for 10 days (mean ± standard deviation).

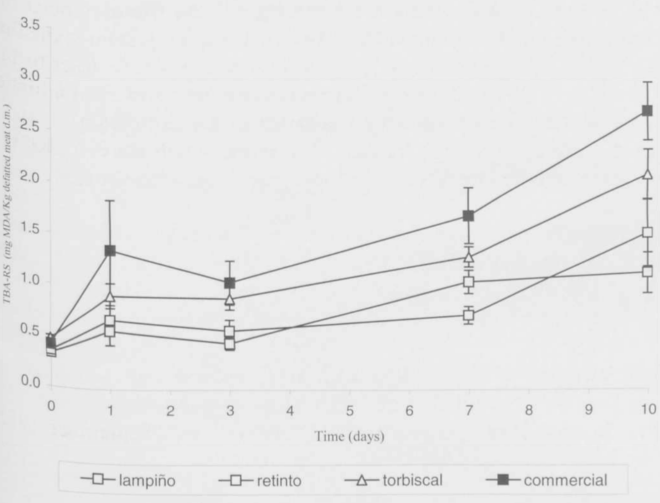

Figure 2. Effect of refrigerated storage (+4ºC for 10 days) over phospholipid content in m. *longissimus dorsi* from three lines of free-range Iberian pigs (*'lampiño'*, *'retinto'* and *'torbiscal'*) and commercial pig.