THE EFFECT OF *ANTE MORTEM* TREATMENT ON BLOOD PARAMETERS AND CARCASS DAMAGE AND ITS RELATIONSHIP WITH PIG MEAT QUALITY.

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BACKGROUND

Slaughter pigs are subjected to a number of specific handling procedures from the time their fattening pens to the moment that they are stunned at slaughterhouse. These practices include removal from the farms, transport (loading and unloading), fasting, mixing with other pigs, exposure to new environments and a type of interaction with humans which they are unfamiliar with. From the animal welfare point of view, it is necessary for the stressors experienced by pigs prior to slaughter to be minimized in order to avoid psychological and physical suffering as well as muscle fatigue. It is also important to prevent the physiological responses (i.e. blood parameters) evoked by the stressful handling conditions from arising, since the elevation of the physiological parameters in blood can coincide with a reduction of meat quality (PSE and DFD) and thus with economical losses for the meat industry.

OBJECTIVES

The aims of this study were to evaluate the effects of the *ante mortem* handling on some physiological parameters in blood (cortisol, creatine phospho-Kinase-CPK and lactate) and study how these parameters affect the technological quality of meat.

METHODS

3273 carcasses of pigs from commercial farms were evaluated in 5 slaughter plants located in different parts of Spain. The data for all pigs were collected during two different seasons of the year (winter and summer). The pigs were allocated to 116 groups (each transport group corresponds to a specific journey).

Information about the different handling practices experienced by pigs during the delivery from the farm to abattoir (loading and unloading techniques, transport conditions, mixing) and about the abattoir conditions was gathered using a questionnaire given to the hauliers and to the abattoir staff. From this information the following variables were selected: fasting on farm, loading time, transport duration, loading density and

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lairage time. The transportation of all 116 groups was carried out using 20 lorries.

Of the 5 abattoirs studied, 3 used a high-voltage electrical stunning system(B, D, E), whereas the rest used a manual and low-voltage electrical stunning system (250 V) (C) and a carbone dioxide stunning system (A). Abattoirs A, C and D operated medium line speeds (240-350 carcasses/hour), whereas plants B and E operated line speeds of 150 and 550 carcasses/hour, respectively.

Each carcass was tagged in order to correlate the blood parameters with the *ante mortem* handling and final meat quality. The amount of skin damage was assessed subjectively using the Meat and Livestock Commission five- point scale based on photographic standards from none (category 1) , moderate (category 2-3) to severe (category 4-5). Blood sampling was conducted at the moment of bleeding to determine cortisol, CPK and lactate levels in the blood. Within each group of carcasses, 32 samples were analyzed for CPK and lactate and 15 blood samples were collected for cortisol analysis. The blood sampled for the assessment of lactate level was collected in tubes filled with fluoride/EDTA (Boehringer Mannheim). The serum and the plasma obtained by centrifugation were frozen in liquid nitrogen pending analysis. Cortisol was measured by using competitive radio-immunoassay, whereas CPK and lactate levels were assessed by totally automatized enzyme Kits (Gernon ref. 43125 and Boehringer Mannheim ref.256773) respectively.

The technological meat quality was assessed on the slaughter-line by using a pork quality meter (PQM). The readings of PQM values were taken in the *m. Semimembranosus* at 1-2 hours *post mortem* when leaving the chilling room. Ultimate pH (pHu) was measured in the laboratory in the same muscle.

The data were analyzed by the General Linear Model procedure of the Statistical Analysis System.

RESULTS AND DISCUSSION

The average number of animals in each of the 116 groups was 148. The loading density was on average 0.37 m^2/pig. If estimated in terms of liveweight, this value would correspond to 270.09 Kg/m^2. These loading densities are high with respect to the thresholds recommended by the European Community.

In winter and at short and long term fasting on the farm (<12h and >18h, respectively) (Table 1) cortisol values were significantly higher (9.19 and 8.48) than in summer (7.09 and 7.00). By comparing the data within the same season, it can be observed that in winter and at a 12-18 hour fasting time the cortisol levels were significantly lower (7.21) than at other fasting intervals. The same tendency has been observed in summer. However, apart from the loading density effects, the cortisol values are significantly higher in the winter season (8.23 and 8.35) than in summer (7.41 and 6.52). These results indicate that the application of a 12-18 hour fasting period before delivery to the abattoir is highly recommendable, as it allows the pigs to cope more easily with the stressful pre-slaughter procedures of loading and transport. The pigs suffer more from feed withdrawal in winter because of the adverse effects of an excessive stomach content (fasting<12h) or even for an inadequate energy supply (fasting>18 h). Our results indicate that pigs suffer from thermal stress, especially in winter. However, at high stocking densities the thermal effects are more stressful in summer, as in winter overcrowding enables the pigs to maintain their body temperature.

The correlation coefficients among the blood parameters evaluated and the indexes of meat quality and the carcass damage score are showed in Table 2. These correlations are significant, although they are not very high. No significant correlation was observed between pHu and PQM. These results indicate that these measurements correspond to different meat quality characteristics. Significant correlations were recorded between three biochemical parameters evaluated in blood and the carcass damage scores as well as between carcass damage values and pHu. No significant correlation was observed between carcass damage scores and PQM values. We believe that the lack of information about the genetic background of the animals evaluated could be the reason for the low correlations obtained and because the damage is underestimated since it only shows up as a result of blows from sticks and nor from pieces of plastic tubing.

In Table 3 the least squares means values (LSM) of the biochemical parameters in blood and meat quality were compared according to the carcass damage score (from 1 to 5). When the mean of the carcass damage is higher, the mean values of concentration of cortisol, CPK and lactate are higher in the blood. The significant elevation of the physiological indicators in the blood and of the pHu values (5.87) at the highest damage score (4-5) reflects the effects of aggression or bad *ante mortem* handling on the animal homeostasis and the depletion of muscle glycogen. This metabolic condition in muscles is likely to be associated with higher incidence of DFD meat.

CONCLUSIONS

The *ante mortem* conditions such as ambient temperature, loading density and fasting duration, represent the main sources of animal suffering especially when the animals are not handled properly. This study would appear to confirm the validity of the measurement of physiological parameters (cortisol, CPK and lactate) in the blood and of carcass damage since they reflect the welfare of the pigs prior to slaughter. In addition, the sharp rise of pHu in the most damaged carcasses indicates a higher incidence of DFD meat leading to greater economical losses for the industry.

Table 1. Effect of season, fasting time on farm and loading density on cortisol levels in blood (Least Squares Means (LSM) and Standard Error (SE)).

	Season				
	Winter		Summer		Signif.
	LSM	SE	LSM	SE	level
Fasting time					
<12 h	9.18[a]	0.28	7.09	0.30	***
12-18 h	7.21[b]	0.33	6.81	0.39	NS
>18 h	8.48[a]	0.39	7.00	0.49	**
Loading density					
<0.40 m^2/pig	8.23	0.19	7.41[a]	0.25	*
≥0.40 m^2/pig	8.35	0.38	6.52[b]	0.45	*

Least Squares Means with different superscripts in the same column are significantly different (P<0.05). *** (P< 0.001); ** (P< 0.01); * (P< 0.05); NS (Not Significant).

Table 2. Correlation coefficients among blood parameters, carcass damage and meat quality.

	1	2	3	4	5	6
1. Lactate	1	0.23	0.15	0.17	0.15	0.14
2. Cortisol		1	0.23	NS	0.18	0.08
3. CPK			1	0.14	0.26	0.14
4. PQM				1	NS	NS
5. pHu					1	0.17
6. Damage[a]						1

All correlation coefficients were significant by P<0.001.
NS (No significant). a. Carcass damage, MLC (1985).

Table 3. Least Squares Means (LSM) and Standard Error (SE) of blood parameters and meat quality characteristics, according to carcass damage score[a].

	None (1)			Moderate (2-3)			Severe (4-5)		
	N	LSM	SE	N	LSM	SE	N	LSM	SE
Cortisol (μg/100ml)	167	7.73[b]	0.24	1400	8.26[a]	0.08	22	9.47[a]	0.66
CPK (log UI/l)	271	3.75[c]	0.02	2518	3.95[b]	0.01	40	4.20[a]	0.06
Lactate (mg/100ml)	278	104.75[b]	2.04	2671	120.00[a]	0.66	46	126.39[a]	5.01
PQM (μs)	267	4.01[b]	0.11	2729	4.39[a]	0.03	44	3.84[b]	0.27
pHu	275	5.64[b]	0.02	2638	5.81[a]	0.01	44	5.87[a]	0.05

a. Carcass damage: 1 to 5 score (MLC 1985).
LSM with different superscripts in the same row are significantly different at the level of P<0.05.