Influence of pre-slaughter conditions and individual traits on skin damage in pigs

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Abstract

A polychotomous logistic regression model was used to assess the risk factors for skin damage during the ante mortem period in pigs. A total of 116 deliveries, comprising 15,695 commercial pigs delivered from different commercial farms to five Spanish pig commercial abattoirs were surveyed. The skin damage condition was described as an ordinal response variable with values 1 (no damage), 2 (very slight damage) and 3 (slight or more damage), in accordance with the MLC photographic scale. The abattoir, the season, the flooring of the lorry, and the stocking density during transportation influenced the occurrence of skin damage. Skin damage increased with on-farm fasting time, loading time, lairage time and carcass weight. The effect of the stocking area depended on the season. PSE and DFD condition can be predicted using the skin damage score as indicator. The risk of PSE and DFD increased 2.6 and 13.0% with increasing the skin damage score from 1 to 3.

Key Words: Skin damage, pre-slaughter treatment, meat quality, PSE, DFD, risk.

Introduction

Skin damage on pig carcasses is a serious welfare and commercial problem. On the one hand, they are depicted as a reflection of bad welfare practices and, on the other hand, they affect negatively carcass grading and pork quality, which may represent an important source of economic losses. Skin damage is due to bruises or blemishes mainly originated from inappropriate housing and handling practices, as well as by fights among animals. Accordingly, they are seen as a good indicator of the state of the animal welfare. Furthermore, as shown in several studies (Warriss, 1996; Gispert *et al*., 2000), skin damage or blemish scores can be used as indicators of pork meat quality. Higher damage scores are related to higher ultimate pH (pH_{24}) and therefore to increased DFD meat condition. The present study investigates the risk factors for skin damage occurrence under commercial conditions in Spain. The same approach is used for assessing skin damage as a risk factor for pork becoming PSE or DFD.

Material and Methods

Animals and measurements. A total of 116 deliveries comprising an overall random sample of 15,695 animals transported to five Spanish pig commercial abattoirs (referred to as A-E) were surveyed over the winter and summer of 1995. A complete description of the abattoirs, pre-slaughter handling practices, transport conditions and stunning methods used in the survey is described by Gispert *et al*. (2000). Skin damage was assessed subjectively in the dressing line using a photographic scale (5-point scale; 1= none, 2= very slight blemish, 3= slight blemish, 4= moderate blemish, 5=severe blemish) provided by the Meat and Livestock Commission (MLC 1985). The PSE condition was assessed by measuring electrical conductivity with the Pork Quality Meter (PQM-I-INTEK, Gmbh, Germany) into the exposed surface of the *Semimembranosus* muscle (SM) in the left side of the carcass, 1-2 h *post mortem*. Carcasses showing PQM values greater than 6 μs were classified as PSE and those greater than 4 but lower or equal to 6 as prone to PSE. Meat was considered as being of normal quality when PQM was ≤ 4 μs. DFD condition was assessed by measuring the ultimate pH (pH_{24}) in 3.075 random samples taken from the exposed surface of the *Semimembranosus* muscle (SM) in the left side of the carcass, 1-2 h *post mortem*. Carcasses showing pH_{24} values greater than 6.2 were classified as serious DFD and those greater than 6.0 but lower or equal to 6.2 as moderate DFD. Meat was considered as being of normal quality when pH_{24} was ≤ 6.0.

Data analysis. Data were analysed with BMDP (Dixon, 1981) using the Polychotomous Stepwise Logistic Regression (PR) procedure, which computes the maximum likelihood estimates of logistic models for multinomial data. Both categorical and continuous variables were included as independent variables. The

categorical variables used in the analyses were the abattoir (A, B, C, D, and E), the season (winter and summer), the effect of mixing unfamiliar animals before or during transportation (mixing or not) and the type of flooring (polyester, aluminium, and iron) of the lorry. The continuous independent variables included in the model are on-farm fasting time, loading time, transportation time, stocking area, lairage time, carcass weight and estimated carcass lean content. The risk of obtaining PSE or DFD pork meat due to skin damage was evaluated using a logistic regression of PSE and DFD pork meat classes on the skin damage score and the logistic regression models used in Guardia *et al*. (2004, 2005) but adding the skin damage score as a new independent variable.

Results and Discussion

The abattoir by season, the type of flooring surface of the lorry, the mixing unfamiliar pigs at loading and the carcass weight significantly affect the risk of carcass skin damage in pigs (results not shown) under surveyed conditions. However, no evidence was found regarding the gender of animals and the lean content. The risk of incidence of skin blemishes varied extensively among abattoirs and seasons (from 0.8% to 64.1%). Overall results discarded iron as appropriate flooring surface and our results showed that mixing unfamiliar pigs during loading reduces the risk of skin damage in 2.4% when compared to unmixed pigs. Furthermore, the risk of obtaining skin damaged carcasses increases with carcass weight (carcasses weighing 70 kg has 4.8% less risk than carcasses weighing 90 kg).

The risk of obtaining skin damaged carcasses increases with on-farm fasting time (Figure 1), loading time (Figure 2) and lairage time (Figure 3). With the results obtained in the present and previous works concerning PSE (Guàrdia *et al*., 2004) and DFD (Guàrdia *et al*., 2005), respectively, an interval of on-farm fasting time from 18 to 20 h is recommended to minimize the risk of skin damage and to optimize meat quality under surveyed conditions. Longer loading times increase the risk of blemished carcasses. Therefore, regarding the risk of skin damage, short loadings are more appropriate than long ones. Loading and unloading may be traumatic for animals and holding them in lairage at the abattoir may help them to recover from previous stressful handling and for this reason an improvement in meat quality is expected. The results obtained in the present work confirm that the risk of skin damage increases with the lairage time. Our results indicate that pigs held in lairage 15 h had around double the risk of skin damage in comparison to pigs held only 3 h (18 vs. 10%). The effect of the stocking density on the risk of skin damage depended on the season (Figure 2). In general, the space allowance during transport resulted to be higher in summer but instead it was much more determining in winter. The risk of skin damage in winter decreases ten-fold when space availability is doubled (from 31.1 to 3.4%, for 0.30 to 0.60 m^2/100 kg) whereas in summer it increases by 6.2% (from 32.2 to 37.6%, for 0.30 to 0.60 m^2/100 kg). Our results stress the importance of the stocking area in winter transports regarding carcass skin damage.

The risk of defective pork meat (PSE and DFD) related to carcass skin damage is shown in Table 1. No significant differences were observed between carcasses scored as very slight and slight or more damage for the risk of both PSE and DFD pork meat. Accordingly, these two latter categories were merged into one and carcasses split up into carcasses with no skin damage and carcasses with skin damage. This result shows that there is a relationship between carcass skin damage and the risk of developing PSE and DFD pork meat but also that it is more dependent on whether there are damages or not than on their degree.

Table 1. Risk of PSE (n= 14236) and DFD (n= 3059) meat by carcass skin damage.

	Skin damage [c]	
	No damage	Damage
PSE [a]		
Normal	67.8	49.3
Prone	28.8	43.7
PSE	3.3	6.9
DFD [b]		
Normal	92.2	75.2
Moderate	4.5	13.1
Serious	3.3	11.7

[a] Prone to PSE= $4 \leq PQM < 6$; PSE= $PQM > 6$; Normal= $PQM < 4$.

[b] Moderate DFD: $6.0 < pH_{24} \leq 6.2$; Serious DFD: $pH_{24} > 6.2$; Normal: $pH_{24} \leq 6.0$

[c] No damage: Score =1; Damage: Score >1.

The risk of occurrence of PSE pork was doubled (6.9%) in skin damaged carcasses as compared to non damaged carcasses (3.3%). Similarly, Table 1 shows that skin blemishes can be used as an index to predict the risk of DFD pork condition. Skin damaged carcasses showed a risk of serious DFD almost four-fold higher (11.7%) than those with no skin blemishes (3.3%), in agreement with the results provided by several authors (Moss and Trimble, 1988; Warriss *et al*., 1998). Estimates obtained using the models in Guàrdia *et al*. (2004, 2005) revealed that skin damage score still had a significant influence on PSE and DFD condition after adjusting for known pre-slaughter management effects, indicating that skin damage scores are able to capture the effect of individual influences of stress on meat quality.

Figure 1. Risk of slight blemish carcass(□) and probability of no carcass damage (o) by on-farm fasting time

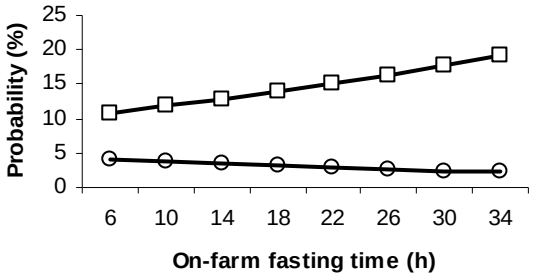


Figure 3. Risk of slight blemish carcass(□) and probability of no carcass damage (o) by lairage time

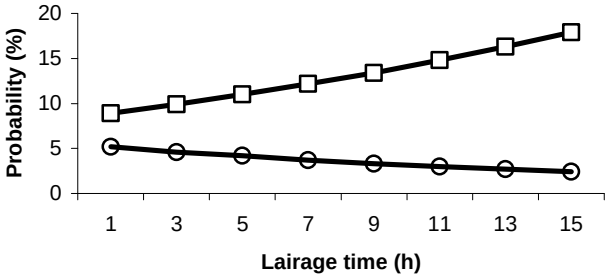


Figure 2. Risk of slight blemish carcass(□) and probability of no carcass damage (o) by loading time

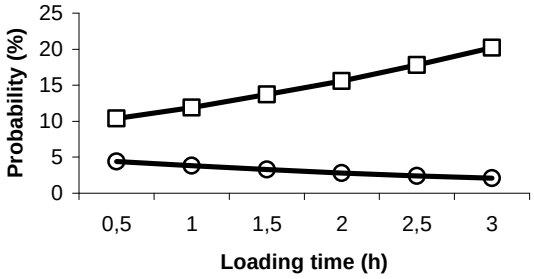
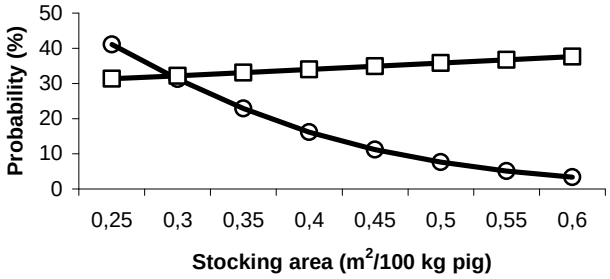


Figure 4. Risk of slight blemish carcass in summer (□) and winter (o) by stocking area during transportation



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