

INFLUENCE OF PRE-SLAUGHTER RESTING TIME ON CARCASS AND HAM QUALITY IN ITALIAN HEAVY PIGS

V. Russo, L. Nanni Costa, D.P. Lo Fiego and A. Pantano

DIPROVAL - Sez. Allevamenti Zootecnici - University of Bologna - Via F.lli Rosselli 107 - 42100 Reggio Emilia - Italy.

Background

The handling of pigs before slaughter has been recognized as an important factor influencing meat and carcass quality. Poor handling during the different steps in the pre-slaughter period, i.e. loading, transport, unloading, lairage, may lead to impaired meat quality and carcass damage with serious economic implications for the processor. In Italy, where about 60% of pig population is destined to produce branded dry-cured hams, particular attention is given on the control of pre-slaughter conditions. A recent survey of pre-slaughter handling of these pigs (Russo *et al.*, 1996) found that the majority of animals are transported for less than 2 h, at stocking density of around 0.41 m² per 100 kg live weight and the usual pre-slaughter rule excludes mixing of unfamiliar pigs in transport or lairage and includes overnight lairage without feed supply. Occasionally, however, transport times exceeding 2 h as well as mixing of unfamiliar pigs at loading can occur. In the latter situation, lairage is usually not prolonged for more than 2 h. Moreover, overnight lairage, foreseen for unmixed pigs, may be substantially reduced if there is a need to supply the slaughter-line. Despite the low occurrence of these types of handling there is a need to study their effect in order to evaluate the possible consequences for carcass and meat quality.

Objectives

The aim of this investigation was to evaluate the effect of different resting times on carcass and meat quality in mixed and unmixed pigs destined to produce branded dry-cured hams.

Methods

A total of 1358 heavy pigs (gilts and barrows; carcass weight kg 136.4 ± 14.6) slaughtered at one plant were examined in two experiments. All pigs were supplied by 10 producers located less than 100 km from or between 150 and 300 km from the abattoir, corresponding respectively to a journey times of less than 2 h and of about 2-4 h. Transport density was on average 0.42 ± 0.02 m² per 100 kg l.w.. For all pigs food was removed about 12 h before loading. The first experiment involved 764 pigs collected from 6 farms where, at loading, mixing between unfamiliar pigs occurred. For each transport time and for each producer, about half the pigs were rested for less than 2 h and half for 3-4 hours before slaughter. The second experiment involved 594 pigs supplied by 4 producers and transported unmixed. For each transport time and for each producer, about half the pigs were held in lairage for 3 h and half overnight before slaughter. In lairage pens, the space allowance for all pigs was on average 0.65 ± 0.02 m² per 100 kg l.w.. At the end of lairage periods all pigs were stunned with CO₂ (80%). Forty-five minutes after slaughter, carcasses were evaluated for skin damage assessed using a photographic standard (scale 1-4: 1=none, 2=moderate, 3=severe, 4=unacceptable) (Barton Gade *et al.* 1996). Unacceptable skin damage was never observed. At the same time pH (pH₁) on *semimembranosus* muscle (SM) of left half carcass was recorded by Crison pH-meter with a combination electrode Ingold Xerolite. After dissection of hot carcass, hams were chilled for 24 h at 0-4 °C and subsequently trimmed for Parma ham processing. During this operation, ultimate pH (pH_u) on SM of each left thigh was measured and the incidence of rejects from Parma processing due to haematoma and pale meat was recorded on almost all hams. The effect of the different lairage times was evaluated within each transport time by T-test for pH measurements and by χ^2 and Fisher exact test for the incidence of severe skin blemish, pH measurements over the threshold value for meat potentially PSE or DFD and hams rejected.

Results and Discussion

Table 1 shows the influence of the resting time on carcass and ham quality in mixed pigs transported for less and more than 2 h. Prolonging lairage from less than 2 h to 3-4 h significantly increased only the incidence of severe skin blemish on the shoulder and middle of pigs transported for more than 2 h. Nevertheless, irrespective of transport time, longer lairage resulted in an increase of carcass damage. Longer resting time also significantly increased the pH₁ on SM in pigs transported for less and more than 2 h, and the pH_u only in pigs subjected to the longer journey. The incidence of pH values over the threshold for PSE and DFD meat was not significantly affected by the lairage time. However, with longer lairage the percentage of pH₁ values lower than 5.90 decreased from 4.8 to 1.3 and from 5.7 to 1.9 for shortest and longest transport respectively. On the other hand, the incidence of pH_u values higher than 6.00 increased from 1.4 to 3.6 and from 2.3 to 5.0 in pigs with short and long journey respectively. The percentage of hams rejected due to haematoma was not influenced by the lairage time even if a tendency for this defect to decrease with longer lairage was found. The latter treatment significantly reduced (P<0.05) the incidence of hams rejected due to pale colour of muscles.

In mixed pigs, a shift of about 2 h in lairage produced, in general, an increase of skin blemish and this was probably due to the greater fighting that ensued. Similar results were achieved by Warris *et al.* (1996) prolonging lairage from 1 to 3 h. The difference in pH₁, pH_u and in percentage of PSE and DFD defects between the resting times examined is in accordance with previous findings showing that even a short extension of holding time leads to increased pH₁, pH_u and DFD incidence and to reduced PSE incidence (Malmfors, 1982; Fortin, 1989; Warris *et al.*, 1996; Santos *et al.*, 1997). Even if it is not possible to compare directly the transport times here examined, the worst results in terms of total incidence of carcass damage, haematoma and pH values over the thresholds for PSE and DFD were found for transport exceeding 2 h.

In table 2 the effect of lairage on carcass and meat quality of unmixed pigs transported for less and more than 2 h is reported. Irrespective of transport time, the differences in percentage of severe skin blemish between the two lairage times were not significant. However, the holding of pigs in lairage overnight resulted in an increase of carcass damage. Regards pH measurements, only the ultimate pH was significantly affected (P<0.01) by lairage and proved to be higher in pigs given overnight lairage after both less than 2 h and 2-4 h transport times. There were no significant differences in percentage of pH measurements over the threshold values for PSE and DFD meat. However, overnight lairage reduced the incidence of pH₁ lower than 5.90 from 7.4 to 3.4 and from 5.4 to 3.3 in pigs



transported for 2 h and for 2-4 h respectively. This treatment resulted also in a slight increase of pH_u values over 6.00 from 0.0% to 2.0% and to 2.6% for shortest and longest transport time respectively. The percentages of hams rejected due to haematoma after 3 h of lairage were not significantly different to those after overnight lairage for both transport times. In pigs transported for both less than 2 h and 2-4 h, the longer resting time gave a reduction of the incidence of ham rejected for meat colour, but this reduction became significant ($P < 0.05$) only for the longer transport. In general, the reduction of lairage time from overnight to 3 h gave a lower incidence of skin damage on carcass and ham and a decrease of pH_u value. This result could be related to the different fasting period that occurred for each resting time, corresponding to about 17 h for the shortest lairage and 26 h for the longest lairage. Prolonged fasting increases the aggressive behaviour of pigs (Kelley *et al.*, 1980) as well as the muscular glycogen depletion which results in an increase of ultimate pH (Eikelenboom *et al.*, 1991). When pigs are fed in overnight lairage these effects are not highlighted (Warris *et al.*, 1990). Nevertheless, overnight lairage showed a positive effect in reducing the incidence of pale meat in the hams without seriously increasing the proportion of meat prone to DFD defect.

Conclusions

In mixed pigs transported for less than 2 h, prolonging lairage to 3-4 h could be positive for the quality of meat because it reduces the incidence of PSE meat without seriously increasing carcass damage. When transport exceeds 2 h this practice should be avoided as its beneficial effect on meat quality could be counterbalanced by an excessive incidence of skin blemish. If pigs are unmixed, the reduction of resting time from overnight to 3 h can slightly reduce the carcass damage but increase the risk of more hams being rejected for pale meat.

Acknowledgements

Research supported by EU (AIR project 262) and MURST 60%.

Pertinent Literature

Barton Gade, P., Warris, P.D., Brown, S.N. and Lambooij, E. (1996) Proc. EU Seminar "New information on welfare and meat quality in pigs as related to handling, transport and lairage conditions" Marianne, Germany, pp. 23-34. - Eikelenboom, G., Bolink, A.H. and Sybesma, W. (1991) Meat Sci., **29**, 25-30. - Fortin, A. (1989) Proc. 35th ICoMST, pp. 981-986. - Kelley, K.W., McGlone, J.J. and Gaskins, C.T. (1980) J. Anim. Sci., **50**, 336-341. - Malmfors, G. (1982) Proc. 28th Europ. Meeting Meat Res. Workers, pp. 21-23. - Russo, V., Lo Fiego D.P., Nanni Costa L. (1996) Produzione Animale, **9**, 115-118. - Santos, C., Almeida, J.M., Matias, E.C., Fraqueza, M.J., Roseiro, C. and Sardina, L. (1997) Meat Sci., **45**, 253-262. - Warris, P.D., Brown, S.N., Bevis, E.A. and Kestin, S.C. (1990) Anim. Prod., **50**, 165-172. - Warris, P.D., Brown, S.N., Edwards, J.E. and Knowles, T.G. (1996) Proc. EU Seminar "New information on welfare and meat quality in pigs as related to handling, transport and lairage conditions" Marianne, Germany, pp. 163-170.

Table 1. Effect of lairage time on carcass and meat quality in mixed pigs transported for two different times (experiment 1)

Transport time Lairage time	<2 h		2 - 4	
	<2 h	3 - 4 h	<2 h	3 - 4 h
No. pigs	207	222	176	159
Severe carcass skin damage (%):				
- shoulder + middle	15.5	18.9	14.2 ^a	24.5 ^b
- ham	1.4	2.2	5.1	6.9
pH ₁ SM†	6.30 ± 0.24 ^a	6.36 ± 0.22 ^b	6.33 ± 0.24 ^A	6.45 ± 0.21 ^B
pH _u SM†	5.56 ± 0.16	5.54 ± 0.17	5.54 ± 0.18 ^A	5.69 ± 0.21 ^B
pH ₁ SM <5.90 (%)	4.8	1.3	5.7	1.9
pH _u SM >6.00 (%)	1.4	3.6	2.3	5.0
No. hams examined	336	361	302	318
Hams rejected (%):				
- haematoma	4.5	2.8	6.6	5.7
- pale meat	7.7 ^a	3.3 ^b	8.9 ^a	1.6 ^b

Table 2. Effect of lairage time on carcass and ham quality in unmixed pigs transported for two different times (experiment 2)

Transport time Lairage time	<2 h		2 - 4 h	
	3 h	overnight	3 h	overnight
No. pigs	148	146	149	151
Severe carcass skin damage (%):				
- shoulder + middle	9.5	13.0	8.0	15.2
- ham	2.7	4.1	1.3	4.6
pH ₁ SM†	6.25 ± 0.21	6.27 ± 0.23	6.25 ± 0.22	6.27 ± 0.21
pH _u SM†	5.51 ± 0.19 ^A	5.56 ± 0.11 ^B	5.54 ± 0.14 ^A	5.59 ± 0.16 ^B
pH ₁ SM <5.90 (%)	4.0	1.4	3.4	1.3
pH _u SM >6.00 (%)	0.0	2.0	0.0	2.6
No. hams examined	286	290	280	278
Hams rejected (%):				
- haematoma	0.3	1.4	1.8	3.5
- pale meat	5.2	3.5	4.3 ^a	1.1 ^b

†: mean ± s.d., a,b: $P < 0.05$; A,B: $P < 0.01$