ABSTRACT

Pigs of two crosses: A (\(\frac{\mathcal{D}}{}\) Duroc x \(\frac{\mathcal{S}}{}\) Swedish Landrace) x \(\frac{\mathcal{P}}{}\) Pietrain (n=24) and B (\(\frac{\mathcal{S}}{}\) Swedish Landrace x \(\frac{\mathcal{L}}{}\) Large White) x \(\frac{\mathcal{P}}{}\) Pietrain (n=26) were used to investigate the effects of different lairage time (2 and 24 hours) on levels of stress and meat quality traits. No direct effect of lairage time on cortisol, lactate, electrolytes and meat quality parameters was observed. However, after long lairage time, pigs showed lower level of glucose and higher CK, AST and ALT activity. Crossbred B pigs exposed to short lairage time, showed higher blood lactate, sodium, and potassium level, higher drip loss and lower pH, whereas there were no significant differences between the crossbreeds in the long lairage group. The results indicate that long lairage time decreases blood glucose level and produces signs of muscle damage. In the short lairage period, the crossbreed B showed a higher response to pre-slaughter handling affecting the meat quality.

Key words: Lairage time, Crossbreed, Blood metabolites, Meat quality

Introduction

The pre-slaughter handling of pigs include removal from the familiar fattening pen, loading, transportation, unloading, mixing with unfamiliar pigs, overcrowding and exposure to novel environmental conditions. The behavioral and physiological changes associated with handling, have been found in earlier investigations (Warris et al., 1998; Fabrega et al., 2002) indicating that all these procedures may impose stress which impairs the welfare and meat quality. Physiological responses to pre-slaughter stress in pigs is associated with changes in plasma cortisol, glucose, lactate, white blood cell (WBC), packed cell volume (PCV), electrolytes, plasma osmolality as well as creatine kinase (CK), lactate dehydrogenase (LDH), aspartate aminotransferase (AST) and alanine aminotransferase (ALT) activity (Schaefer et al., 1997; Perez et al., 2002). Pre-slaughter stressors also change muscle glycogen metabolism and affect meat color, water holding capacity (WHC) and technological traits (Gispert et al., 2000). Short pre-slaughter stress may cause a rapid fall in muscle pH post mortem and the development of pale, soft and exudative (PSE) meat. Long term stress conditions cause muscle fatigue and depletion of muscle glycogen at slaughter, producing dark, firm and dry (DFD) meat. The incidence of PSE and DFD meat is largely influenced by the genotype of the pig (Gispert et al., 2000) and lairage time (Santos et al., 1997). Precise period of rest and its influence on levels of stress is not well defined. Using the changes in the blood profile as an indicator, Warris et al. (1998) found that the overnight lairage reduced the amount of stress. Perez et al. (2002) observed that the absence of...
lairage or excessively long lairage period without feed intake caused higher level of stress and poor meat quality. This study was designed to evaluate the stress response of two different group of crossbred pigs to a long (24 h) and short (2 h) lairage time and its influence on the meat quality traits.

Material and methods

A total of 50 pigs of two crosses: A (♀Duroc x ♀Swedish Landrace) x ♂Pietrain (n=24) and B (♀Swedish Landrace x ♀Large White) x ♂Pietrain (n=26), weighing between 100 and 110 kg were used in this experiment. All of the pigs were fattened at the same farm, in the 4 pens, which held between 12 and 16 pigs of both sexes, each. The pigs were transported together, in the same truck, in the early morning. The traveling distance from the farm to the abattoir was 80 km. The transportation conditions and handling procedures were the same for all the pigs included in the study. The fasting time preceding loading was about 12 h. At the unloading pigs were randomly divided into two lairage groups. The short lairage group was composed of pigs that were slaughtered within 2h after the arrival at the abattoir. Pigs from the long lairage group were rested in the same batch for 24 h without feed but with free access to fresh water. Blood samples were collected before loading and at exsanginations. Plasma cortisol, lactate, CK, AST, ALT, LDH and electrolytes (sodium, potassium and chloride) were analyzed by standardized methods and equipments. On the Longissimus dorsi muscle the initial (pH<sub>i</sub>) and the ultimate (pH<sub>u</sub>) pH were taken at 45 min and 24 h after slaughter, respectively. The water holding capacity (WHC) was measured on the same muscle at 24 h post mortem according to Honikel et al. (1998). The data were analyzed statistically by SAS software (v. 8.1, 1999). The effects of crossbreed and lairage time on blood parameters were analyzed using GLM procedure. The model was fitted for main effects (crossbreed and lairage time) as well as interaction between main effects, using the preload concentration as a covariate. Meat quality parameters were analyzed using the GLM procedure with crossbreed, lairage time and their interaction as fixed effects. The effects were considered significant if P<0.05.

Results and conclusions

Least square means (standard errors) of the blood and meat quality parameters from the two crossbreeds within short and long lairage time are given in Table 1.

The results in Table 1 showed that cortisol levels were high in all the groups in comparison to preload levels (mean preload levels of cortisol were 2.52 and 2.61 in the short lairage group and 2.34 and 2.17 in the long lairage group, for A and B crossbreed, respectively), indicating stress response activation. This finding is in the agreement with earlier investigations (Kannan et al., 2000) and the idea that the loading, transportation and unloading can be significant stressors. As shown in Table 1, there was not a significant effect of the lairage time, crossbreed or their interaction on plasma cortisol concentration. Lairage time had a significant effect (P<0.01) on serum glucose concentration and CK, AST and ALT activity. The pigs in the long lairage group showed significantly lower level of glucose and higher CK, AST and ALT activity compared with the pigs in the short lairage group. High plasma cortisol level and the increase in blood enzymatic activity of CK, AST and ALT indicate that pigs in the long lairage group were exposed to extensive muscular activity and physical stress (Payne and Payne, 1988) and indirectly indicate the amount of muscle damage and therefore meat quality (Kannan et al., 2000). Other authors (Perez et al., 2002; Fabrega et al., 2002) have also reported an increase in plasma cortisol and CK, AST and ALT activity after transport and prolonged lairage time. They also found decrease in serum glucose concentration as lairage time increased and explained it as a result of a prolonged fasting time. Serum lactate, potassium and sodium concentrations were not directly affected by lairage time but there was a significant (P<0.05) lairage time x crossbreed interaction for these blood parameters. In the short lairage group, lactate, potassium and sodium concentrations were higher in the B crossbred pigs compared with A crossbred pigs, whereas in the long lairage group no significant differences between the two crossbreeds were observed. There was also a significant interaction between crossbreed and lairage time for all meat quality parameters with the exception of pH<sub>u</sub>.
value. In the short lairage group, the crossbreed B showed a lower pH\(_i\) value (P<0.01) and a higher drip loss (P<0.05) compared with crossbreed A, whereas crossbreed did not alter the pH\(_i\) or the drip loss in the long lairage group. Elevated blood lactate levels originate from the breakdown of the muscle glycogen as a result of extreme muscular activity and from the catecholamine release leading to rapid glycogenesis. Accordingly, higher blood lactate level in the crossbreed B may indicate a higher response to physical exercise and psychological stress in the immediate pre-slaughter period. Such thesis is supported by the tendency of developing rapid muscle acidification and consequently a higher drip loss observed in the same group. The results of the present experiment indicate that long lairage time decreases blood glucose level and produces signs of muscle damage. A different reaction to pre-slaughter handling between crossbreeds was observed only in the short lairage period with a higher response to pre-slaughter stress and poor meat quality in the crossbreed B.

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**Table 1. Effects of lairage time and crossbreed on blood and meat quality parameters.**

| Lairage time | Short - 2 h | Long - 24 h |
|--------------|-------------|-------------|
| Crossbreed   | A           | B           | A            | B             |
| Blood parameters |             |             |              |               |
| Cortisol (mmol/l) | 8.43 (0.56) | 8.28 (0.59) | 7.66 (0.54) | 8.59 (0.54) |
| Lactate (mmol/l) | 10.54 (0.80) | 14.74 (0.84) | 8.44 (0.76) | 8.47 (0.76) |
| Glucose (mg/dl) | 6.70 (0.19) | 7.25 (0.20) | 5.16 (0.18) | 5.35 (0.18) |
| CK (U/L) | 9206 (3073) | 10939 (2898) | 26763 (2749) | 22787 (2622) |
| LDH (U/L) | 3420 (234) | 3084 (234) | 2679 (222) | 1942 (211) |
| AST (U/L) | 76.08 (7.35) | 72.83 (7.75) | 72.75 (3.35) | 75.27 (3.25) |
| ALT (U/L) | 53.96 (3.24) | 57.49 (3.29) | 6.65 (0.27) | 6.51 (0.37) |
| Potassium (mmol/l) | 6.58 (0.28) | 8.24 (0.30) | 100.96 (0.54) | 101.38 (0.54) |
| Chloride (mmol/l) | 99.96 (0.57) | 101.14 (0.60) | 148.48 (0.93) | 148.37 (0.93) |
| Sodium (mmol/l) | 145.96 (0.98) | 151.74 (1.0) | 148.48 (0.93) | 148.37 (0.93) |
| Meat quality |             |             |              |               |
| pH\(_i\) | 6.47 (0.08) | 6.07 (0.07) | 6.09 (0.08) | 6.10 (0.08) |
| pH\(_u\) | 5.63 (0.04) | 5.56 (0.03) | 5.66 (0.04) | 5.61 (0.04) |
| Drip loss (%) | 5.56 (0.61) | 7.79 (0.59) | 6.32 (0.66) | 6.24 (0.66) |

Means within row with different superscript (a, b, c) differ at P<0.05.