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Effect of lairage time on pork quality

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Introduction

Lairage is a part of slaughterhouse where animals temporarily stay prior to slaughter, to recover from transport and other stressors. During lairage pigs rest which improves meat quality. However, lairage is often accompanied by economic losses due to death, skin damage and lower meat quality as a result of inadequate design of pens and corridors, environmental conditions, lairage time, handling procedures and mixing with other pigs in lairage pens (Warriss, 2003a). Nanni Costa et al. (2002) found that more than other procedures before slaughter, lairage time has the most significant influence on pork quality. Optimal lairage time for pigs is 2-3 hours (Warriss, 2003a). After 2-3 hours of lairage a level of blood cortisol decreased to basal values in pigs (Perez et al., 2002), indicating a reduction of stress. It was observed that pigs were easily handled after rest of 1-3 hours and the incidence of pale, soft and exudative (PSE) meat in these animals was lower (Perez et al., 2002; Warriss, 2003a). On the other hand, the slaughter of pigs immediately after unloading or after a short lairage (15-60 minutes) is not recommended, because pigs are exhausted and upset, and meat has higher temperature and lower initial pH value, which contributes to higher incidence of PSE meat (Warriss, 2003a). Since lairage time may have positive, but also negative impact on pork quality, the objective of this study was to determine correlations between lairage time and pork quality traits.

Materials and Methods

The experiment was conducted during September and October 2011 on 100 commercial market hogs derived from crossing Naima sows with hybrids P-76 PenArLan boars, with live weight between 115 and 130 kg. Pigs were transported 3 km to commercial slaughterhouse and held in lairage for short (1.36±0.91 h) or long periods (17.01±1.82 h). Before transport pigs were not fasted, but in the lairage, feed and water were restricted. After lairage pigs were electrically stunned and humanly slaughtered and then carcasses were processed using conventional industry practice. At slaughter blood samples were taken into plastic tubes containing heparin (against blood coagulation) and thereupon lactate content was determined using a portable lactate analyzer (Lactate Scout, EKF Diagnostic, Magdeburg, Germany). After blood collection the tubes were placed on ice and within 4 - 6 hours blood was centrifuged at 3000 rpm for 3 minutes. Supernatants (plasma) were collected into microtubes and stored at –20°C until the determination of cortisol concentration by radioimmunoassay (RIA-CT Cortisol, INEP, Belgrade, Serbia). Meat quality measurements were carried out 60 minutes, 24 and 72 hours after slaughter on muscle *Longissimus dorsi* (LD), *pars lumbalis*. Value of pH and temperature were measured using a pH-meter "Testo 205" (Germany) 60 minutes and 24 hours *post mortem*. Drip loss was estimated at 72 hours after slaughter according to Honikel (1998). L^*, a^* and b^* values were determined at 24 hours *post mortem* using a Minolta Chroma Meter CR-400 (Minolta Co., Ltd., Osaka, Japan) utilizing a 65 light source and a 2° observer. Analytical panel of 3 members assessed sensory colour and marbling by using the scaling method after an approximate 60 minutes of blooming time (NPPC, 2000). Skin blemishes were assessed on both sides of carcass immediately after dressing using scores 1 (none), 2 (slight), 3 (moderate) and 4 (severe). Intensity of rigor mortis was estimated 3 hours *post mortem* by measuring degree of angle between body axis and foreleg (Davis et al., 1978). Correlations between lairage time and pork quality traits were expressed by using Pearson correlation coefficient. All data were analyzed in GraphPad Prism 4.

Results and Discussion

Effect of lairage time on lactate and cortisol content in pigs and pork quality parameters is shown in Table 1.

Table 1. Pearson correlation coefficient between lairage time and pork quality parameters

Parameters	Lactate	Cortisol	pH_i	pH_u	t_{60min}	DL	SB	RM	SC	*L**	*a**	*b**	Marbling
Lairage time	0.21*	-0.12	0.02	0.0004	-0.14	-0.23*	0.35***	-0.27**	0.20*	-0.39***	-0.25*	-0.40***	0.26**

pH_i - initial pH; pH_u - ultimate pH; DL- drip loss (72h); SB - skin blemishes; RM - rigor mortis; SC - sensory colour;
* ($p<0.05$); ** ($p<0.01$); *** ($p<0.001$).

After longer lairage blood cortisol content decreased (r= -0.12) which was also observed by Warriss (2003a) and Perez et al. (2002) suggesting that during lairage, particularly at night, pigs rest and calm down. On the other hand, lairage time was positively correlated with blood lactate content (r = 0.21*), which as a measure of stress indicates that a longer lairage causes higher level of stress. This could be explained by the fact that pigs after longer lairage were more susceptible to stress due to longer period of experiencing stressors in lairage (rough handling, mixing with unfamiliar pigs, change of environment, restriction of food and water, etc.). In this study no significant correlation between lairage time and pH values of meat 60 minutes (r= -0.02) and 24 hours (r= -0.0004) after slaughter was observed, indicating that lairage time did not influence pH value of meat. On the contrary, Milligan et al. (1998) and Hoffman and Fisher (2010) found that lairage time affected the initial pH value of meat, so increasing pH value correlated with a longer lairage time. This is explained by the fact that reserves of glycogen are depleted during lairage and after a longer lairage there is a lower muscle glycogen content and consequently higher pH value of meat. As there is a positive correlation between initial and ultimate pH value of meat, the ultimate pH value of meat was significantly lower after two hours compared to 22 hours of lairage (Perez et al., 2002; Nanni Costa et al., 2002). In addition, Carr et al. (2008) found that during the first three hours of lairage there was a statistically significant increase in ultimate pH of meat with lairage time. In the current study, a negative correlation (r = -0.14) was determined between lairage time and temperature of meat 60 minutes after slaughter, in accordance with results of Milligan et al. (1998) and Hambrecht et al. (2005). With longer lairage, drip loss was lower (r = -0.23*), indicating that water holding capacity (WHC) was higher after longer lairage. This was due to dehydration of pigs during lairage, since food and water were restricted and meat contained less water. Also, Warriss (2003a) concluded that with longer lairage increased WHC expressed through drip loss. In pigs that stayed two hours in lairage, drip loss was significantly higher compared to a longer lairage time (Warriss, 2003a, Hoffman and Fisher, 2010; Salajpal et al., 2005). This can be explained by the influence of pH value on WHC of meat, which is higher when pH value of meat is higher, as it is after a longer lairage. In addition, longer lairage increased the level of skin blemishes on carcass (r = 0.35***). The percentage of skin blemishes is higher after a longer lairage time because it increases the aggressiveness in pigs (Nanni Costa et al., 2002; Perez et al., 2002; Warriss, 2003a). In addition, longer lairage time increases the frequency of carcasses with medium and severe injuries (Warriss et al., 2003a). Risk of injuries is almost doubled after 15 hours (18 %) in relation to three hours of lairage (10 %) (Guardia et al., 2009). The fighting reaches a peak after 40-60 minutes of lairage and thereafter gradually subsides. However, a higher level of injuries on carcasses after a longer lairage time indicates that fights last throughout lairage, just at lower intensity. This fighting contributes to skin blemishes and if severe, reduces carcass value (Faucitano, 2001). Lairage time affected meat color, so longer lairage increased sensory colour score (r = 0.20*) and decreased *L** (r = -0.39***), *a** (r = -0.25*) and *b** values (r = -0.40***), indicating that meat became darker, less red and yellow, which also was observed by Nanni Costa et al. (2002) and Hoffman and Fisher (2010). During lairage, glycogen stores become depleted, pH value of meat is higher and therefore meat is darker (Warriss, 2003a). Higher marbling score was determined after longer lairage (r = 0.26**) due to dehydration when myofilaments lose water and shrink, so content of intramuscular fat appeared higher. Negative correlation was determined between lairage time and angle between body axis and foreleg (r = -0.27**), which means that intensity of rigor mortis was higher after a longer lairage. Since the rate of rigor mortis is positively correlated with the content of cortisol and lactate as indicators of stress (Warriss et al., 2003b), a greater degree of rigor mortis after longer lairage indicates a more stressful procedure.

Conclusions

- Lower temperature, higher WHC and darker colour of meat after longer lairage time indicate that lairage time positively affects pork quality.
- Higher lactate content, skin blemishes score and intensity of rigor mortis after longer lairage time suggest that longer lairage time compromises animal welfare and reduces carcass value.
- Therefore, it is necessary to follow recommendation of 2-3 hours of lairage in order to improve pork quality and ensure animal welfare.

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