

EFFECTS OF LAIRAGE CONDITIONS AND TIME ON PORK QUALITY (A REVIEW)

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SUMMARY: Since pigs spend some time in a lairage, it is necessary to pay attention to the conditions in which animals are, and which affect the welfare and meat quality of pigs. In practice, lairage time differs, but it is recommended to be 2-3 hours. Too short lairage time adversely affects pork quality because meat has a lower pH, higher temperature, lower WHC, brighter color, which is recognized as PSE meat. On the other hand, too long lairage time also is not desirable, due to increased incidence of damaged carcasses and DFD meat. Therefore, it is necessary to know and follow recommendations regarding lairage conditions and time in order to save and enhance welfare and meat quality of pigs.

Keywords: pig welfare, pH, WHC, PSE, DFD.

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 damages 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, 2003; Faucitano and Gavernik, 2008). In addition, lairage may be a reservoir of infections by pathogenic bacteria, so there is an evidence that longer lairage time increases the possibility of carcass contamination (Warriss, 2003). As the lairage conditions and time may have a positive, but also nega-

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tive impact on pig welfare and pork quality, attention to this segment of pork production gains importance.

LAIRAGE CONDITIONS

During design, construction, and assessment of lairage conditions it is necessary to pay attention to the lairage capacity, layout, form and size of boxes and passageways, space allowance, floors, efficiency of ventilation, temperature, humidity, intensity of light and noise and availability of drinkers and feeders in lairage pens (Farm Animal Welfare Council, 2003).

The slaughter should be planned depending on lairage capacity, otherwise may occur overcrowding of animals in pens or waiting too long in vehicles to unload. Such events cause poor animal welfare.

Layout, form and size of boxes and corridors in lairage should be in such way designed to facilitate manipulation of animals and to encourage them to move from unload to slaughter area. The passageways between unloading area, pens and stunning boxes should be as short as possible and without sharp corners. Poorly designed lairage makes pig handling difficult, reduces productivity of slaughterhouse and also pig welfare and safety of staff. Lairage should be built from solid and resistant materials, such as concrete and metal, to protect pigs from adverse weather conditions (OIE, 2010). In addition, it is desirable to have flexible railings in order to optionally subdivide pens and avoid mixing of unfamiliar pigs. Mixing of unfamiliar pigs during transport and lairage is not advisable. During life pigs develop social hierarchy, which is disordered if unknown individuals are introduced to a group. Then pigs start to fight in order to establish a new hierarchy. The fighting reaches its peak after 40-60 minutes of lairage and thereafter gradually subsides. However, a high level of injuries on carcasses after longer lairage time indicates that fights last throughout lairage, but only at lower intensity (Gispert et al., 2000). These fights contribute to skin blemishes and if they are severe, reduce carcass value (Faucitano, 2001). Additionally, fights increase lactate and cortisol level in blood, reduce muscle glycogen stores and therefore meat has a higher pH value after 24 hours (Warriss et al., 1998a). Moreover, aggressiveness in pigs is provoked by longer period of fasting (Turgeon, 2003). If it is impossible to avoid mixing of individuals, it is desirable to reduce the size of a group, because it reduces aggressiveness in pigs. Researches of Barton-Gade (1997) indicated that a small group of mixed animals, which consisted of 15 pigs, reduced anxiety and more animals were resting. The former has been confirmed by Rabaste et al. (2007) who observed that groups of 30 pigs spent more time standing and fighting than 10 pigs in the group with the same stocking density (0,59 m² per pig).

Each animal should have enough place to stand up, lie down and turned around when it is in lairage pen (Farm Animal Welfare Council, 2003). Insufficient space area per animal may be allowed if pigs are for a short time in lairage, but if they are held overnight or a longer period of time, it is necessary to provide more space per pig. Although in practice space allowance for pigs with live weight of 100 kg varies from 0,3 to 2,7 m², it is recommended to be 0,5 m² (Chevillon, 2001). In Table 1 are given recommendations for space allowance depending on pig live weight (RSPCA welfare standards for pigs, 2010). However, the size of available area per pig affects their behavior. At high stocking density fighting is limited as pigs mostly interact with few pigs

in proximity. On the contrary, at low stocking density the number of fights has been increased due to more mixing of individuals, although these conditions give more opportunities for subordinate pigs to escape from dominant ones (Weeks, 2008). As much of the fights occurs in the first hour of lairage, Weeks (2008) suggests a higher stocking density (0,42 m²/pig) for a short lairage (< 3 h) and lower stocking density (0,66 m²/pig) for a long lairage (> 3 h).

Table 1. Lying and total area per pig depending on live weight

Live weight (kg)	Lying area (m ²)	Total area (m ²)	Live weight (kg)	Lying area (m ²)	Total area (m ²)
10	0,10	0,15	70	0,41	0,61
20	0,15	0,225	80	0,45	0,675
30	0,20	0,30	90	0,475	0,715
40	0,26	0,40	100	0,50	0,75
50	0,31	0,47	110	0,53	0,80
60	0,36	0,55	//	/	/

Lairage surfaces must not have sharp edges and protruding parts that could injure pigs. The floors of lairage should be designed, constructed and maintained in such way to minimize the risk of slipping and falling (OIE, 2010). Slipping and falling is particularly evident at unloading areas, entrances to the pens and along the corridor that leads to the stunning area, which depends not only on floor surface, but also on lairage design and handling procedures. Conditions of the floor can be assessed by scoring the number of animals that slipped and fell on these critical points. According to this, it is unacceptable if 1% of pigs falls, but if 5 % fall or 15 % slipp, that indicates serious problems in the slaughterhouse (Farm Animal Welfare Council, 2003). In addition, different types of floor are not desirable in lairage, because it may interfere with pig moving.

It is necessary to provide efficient ventilation in lairage in order to control temperature, humidity and concentration of ammonia and other noxious gases. Also, it is recommended that temperature is 15-18 °C and humidity 59-65 % in lairage. When these recommendations are not followed, pigs suffer from cold stress, especially at low stocking density, or from heat stress, at high stocking density, temperature above 30 °C and humidity above 80 %. Efficient ventilation and water spraying can reduce adverse effects of high temperature and humidity.

Adequate lighting should be provided in lairage. However, very intensive light and shadows fear pigs and they become distracted during movement. Pigs readily move from darker to brighter areas, so this principle can be used for easier handling.

Also, during lairage pigs should be protected from excessive noise by avoiding the use of noisy hydraulic or pneumatic equipment, muffling metal equipment or preventing expansion of noise to the area where pigs are (OIE, 2010). The sound level in a lairage varies from 76 to 108 dB on average, with highest levels in stunning area (120 dB) (Rabaste et al., 2007). The sudden and high-pitched sounds can be a source of stress, as shown by high blood lactate, creatine phosphokinase and cortisol level, increased heart rate (Kanitz and Tuchscherer, 2005), while pigs huddle together or escape from sound sources. There was a relationship between the intensity of noise in lairage and the degree of pH fall in meat as a response to the stress (van de Perre et al., 2010).

Pigs in lairage should have permanent access to the water in order to recover from dehydration caused during transport. Food should be provided if pigs stay in a lairage more than 12 hours.

LAIRAGE TIME

Nanni Costa et al. (2002) found that more than other procedures before slaughter, lairage time has the most significant influence on pork quality. Lairage time affects the level of stress in pigs, because it can compensate negative effects of loading, transporting and unloading. Optimal lairage time for pigs is 2-3 hours (Warriss, 2003). 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. Also, Warriss et al. (2003) came to similar conclusions and found that cortisol blood concentration in pigs after 2-3 hours of lairage was two times lower than after one hour of lairage. 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, 2003). After two hours of lairage pigs become calmer and fightings stop (van der Wal et al., 1999). In addition, Fortin (2002) found that lairage improved pork quality, regardless of transport duration. On the other hand, the slaughter of pigs immediately after unloading or after short lairage (15-60 minutes) is not recommended, because pigs are exhausted and upset. Then there is an increase in muscle temperature (+1 °C) immediately before slaughter and also an increase of lactic acid in muscles, which contributes to higher incidence of PSE meat (Warriss, 2003; Warriss et al., 1998b; Owen et al., 2000; Shen and al., 2006).

Lairage time affects the initial pH value of meat (Milligan et al., 1998) and in pigs that were not resting pH value of meat (after 30 minutes of slaughter) was significantly lower than after three hours of rest. Also, increasing of pH value with a longer lairage time determined Panella-Riera et al. (2012) and Hoffman and Fisher (2010). This is explained by the fact that the reserves of glycogen are being 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 final pH value of meat, the final pH value of meat was significantly lower after two hours in relation 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 is a statistically significant increase in ultimate pH of meat with a lairage time. Researches of Milligan et al. (1998) showed that longer lairage time reduced the temperature of meat after 90 minutes of slaughter, so in pigs that were not rested was 41,5 °C and after three hours of rest 39,0 °C. With longer lairage time increases the water holding capacity (WHC) expressed through drip loss (Warriss et al., 2003). In pigs that stayed two hours in lairage drip loss was significantly higher compared to a longer lairage time (Warriss et al., 2003, Hoffman and Fisher, 2010; Salajpal et al., 2005). This can be explained by the influence of pH value on WHC of meat that is higher when pH value of meat is higher, as it is after a longer lairage. Lairage time affects meat color, so longer lairage depletes glycogen stores, pH value of meat measured 60 minutes and 24 hours after slaughter is higher and meat is darker (Warriss et al., 2003). Nanni Costa et al. (2002) have found significantly darker meat color after a longer lairage. This is confirmed by the results of Hoffman and Fisher (2010) who found a significantly higher ($p < 0,05$) L * value after two hours ($58,65 \pm 0,62$) compared to 24 hours of lairage ($56,41 \pm 0,68$).

The percentage of skin blemishes is higher after longer lairage time because it increases the aggressiveness in pigs (Warriss et al., 1998b; Nanni Costa et al., 2002; Perez et al., 2002; Warriss, 2003). In addition, with longer lairage time increases the frequency of carcasses with medium and severe injuries (Warriss et al., 1998b). Risk of

injuries is almost doubled after 15 hours (18%) in relation to three hours of lairage (10%) (Guardia et al., 2009).

Warris et al. (1998b) studied the effect of lairage time on development of meat quality defects and found that longer lairage time reduced the incidence of PSE meat, but increased the incidence of dark, firm and dry (DFD) meat. Accordingly to these findings are results of Perez et al. (2002) and Nanni Costa et al. (2002) who concluded that percentage of PSE meat decreases and DFD meat increases with longer lairage time. However, Guardia et al. (2004) found that the differences in PSE meat risk between short and long lairage time were insignificant. The possibility of developing PSE meat after three hours of lairage was estimated at about 40 %, while lairage time of 10 hours increased risk for only 2 %. On the contrary, significant differences were found in the risk of DFD meat in pigs with different lairage time. After three hours the possibility of developing DFD meat is about 12 %, while after overnight lairage increases to 25 % (Guardia et al., 2005). Increased risk of DFD meat with longer lairage time is a result of glycogen store depletion due to starvation and fighting between pigs (Nanni Costa, 2002).

Regardless of recommendations, the optimal lairage time very depends on conditions in lairage (eg. size of boxes), mixing of unfamiliar individuals and intensity of stress that pigs experienced during transport.

CONCLUSION

Although the main purpose of lairage is animal rest and recovery from stress, it can be a major cause of pork quality deterioration. Lairage conditions and time can be relatively easily controlled in a slaughterhouse, so it is necessary to know and follow recommendations regarding lairage conditions and time in order to save and enhance pig welfare and pork quality.

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USLOVI I DUŽINA BORAVKA U STOČNOM DEPOU I NJIHOV ZNAČAJ ZA KVALITET MESA SVINJA

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Izvod

Kako svinje borave određeno vreme u stočnom depou, neophodno je obratiti pažnju na uslove u kojima se životinje nalaze, a koji utiču na dobrobit i kvalitet mesa svinja. U praksi se razlikuje vreme boravka svinja u stočnom depou, ali preporučuje se da bude 2-3 sata. Suviše kratko vreme boravka nepovoljno se odražava na kvalitet mesa svinja, zato što takvo meso ima nižu pH vrednost, višu temperaturu, slabiju SVV, svetliju boju, što se prepoznaje kao BMV meso. Sa druge strane, dugo vreme boravka u stočnom depou takođe nije poželjno, jer su trupovi više oštećeni usled ozleda, a meso se često klasifikuje kao TČS. Stoga, neophodno je poznavati i poštovati preporuke vezane za uslove i dužinu boravka u stočnom depou kako bi se očuvali, ali i poboljšali dobrobit i kvalitet mesa svinja.

Ključne reči: dobrobit svinja, pH mesa, SVV mesa, BMV meso, TČS meso.

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