EFFECT OF HIGH AMBIENT TEMPERATURE ON MEAT QUALITY OF PIGS

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Abstract

Environmental temperature is known to influence the performance of growing pigs. Pigs are quite sensitive to high temperatures and the climate changes could lead to changes in quality of meat. The aim of this experiment was to assess the effect of high temperature on meat quality characteristics on Large White breed. This trial was carried out in Experimental centre of livestock in Nitra and lasted three months. Pigs were divided into two groups; experimental group of seven pigs was housed in climatic chamber with constant temperature 30 °C. Control group of six pigs was reared in standard conditions in the pen. The experiment started when the pigs reached 30 kg and all the pigs were slaughtered according to legislation at about 100 kg. Pigs were offered diet ad libitum. The *M. longissimus thoracis* (MLT) and *M. semimembranosus* (MSM) was used to asses meat quality characteristics. Ultimate pH was recorded 45 minutes and 24 hours post-mortem and also the electric conductivity. Meat colour of samples was measured 24 hours after slaughtering and samples intended for Warner–Bratzler shear force were also evaluated. It was found that pigs influenced by high temperature had significantly lower ($P \leq 0.05$) muscle pH after 24 hours postmortem in MSM (5.59) compared to pigs in standard conditions (5.67). Electric conductivity in MSM after 24 hours was significantly lower ($P \leq 0.05$) in pigs housed in pen (9.75 mS^{-1}). In conclusion high temperature had no significant effect on meat quality of pigs in parameters shear force, drip loss and meat colour.

Key Words: High ambient temperature, meat quality, pigs

Climate change, particularly global warming, may strongly affect production performances of farm animals and impact worldwide on livestock production. Hot weather adversely affects the performance of pig production. Pigs are very sensitive to hot conditions. This is mainly due to the low sweating capacity (Nardone, et al., 2010). The thermoregulation mechanisms of pigs represent great expenses in energy for heating loss. Environmental temperature and humidity alters pig's metabolic system and reduces production performance and carcass quality (Fagundes et al., 2009). In general, transportation conditions by Berg (2010) affect post-mortem meat quality by provoking stress or animal fatigue. High temperature and humidity are extremely dangerous for pigs because of their inefficient means of heat respiration. According to Gregory (2010) pigs reared from weaning to slaughter in alternating high and low environmental temperatures developed paler meat compared to being reared at constant temperature. In Danish Landrace pigs, summer conditions have been associated with paler meat colour compared with wintertime. High temperature can also increase the risks of pale-soft-exudative (PSE) meat in pigs. Van de Perre et al. (2010) reported that in summer, the risk of PSE is almost twice the risk in winter because pigs are sensitive to high temperature. Both high environmental temperatures in summer and temperature fluctuations affect the animal's ability to maintain body temperature which results in stress, a higher post-mortem muscle temperature and poorer meat quality.

Large White pigs reared in a tropical climate had a higher pH, lower moisture loss that could mean tropical climate may have a favourable effect on pork quality (Nardone, et al., 2010). Lefaucheur et al. (1991) mentioned that both pH 45 min *postmortem* and pH 24 h *postmortem* were significantly lower in *longissimus* muscle of pigs reared in 12 °C than in 28 °C. The parameter pH 45 min of 12 °C was just above the critical value of 5.9 under which the PSE syndrome may occur. Hansen, Biensen (2009) found out that lower pH occurred in the summer and higher pH ratings were found in the winter and Mota-Rojas et al. (2006) reported that transport in relatively short periods in July in summer significantly increased the incidence of lower pH 45. According to Rinaldo, Mourot (2001) ultimate pH of muscles *longissimus dorsi* and *biceps femoris* was higher in the tropical climate than in cool climate with constant temperature 20 °C whereas moisture loss of the *biceps femoris* and *semispinalis* muscles was lower. The variation in drip loss reported by Brown et al. (2012) from *longissimus dorsi* muscle due to season interactions differed from that in *semimembranosus*. Drip loss was significantly greater in summer than in winter. Lefaucher et al. (1991) showed that moisture loss determined 24 h *postmortem* was lower in *semispinalis* muscle than in *longissimus* muscle. It was lower in *semispinalis* of pigs reared in 12 °C than of 28 °C. Dalla Costa et al. (2007) found out that the light reflectance value in the *longissimus* and *semimembranosus* muscles was significantly influenced by the season of the year,

the *longissimus* and *semimembranosus* muscles were paler in summer than in winter. It was found a higher light reflectance in pork loin and ham from pigs slaughtered at high temperatures (35 °C) and it was confirmed the negative effect of heat stress on the *postmortem* muscle metabolic process resulting in inferior pork quality.

The objective of this study was to evaluate the impact of high ambient temperature on meat quality characteristics of Large White pigs.

Material and Methods

Experiment was carried out in the laboratory conditions of the Experimental centre of livestock in Nitra and lasted 3 months, from October till December. The trials included breed Large White. In this study 2 groups of 6 growing pigs (control group) and 7 growing pigs (experimental group) were used. The experimental group of pigs (4 ♀, 3 ♂) was housed in a climatic chamber, size was 4 x 3 m and air temperature was constant 30 ˚ C ± 1.0 degree, depending on the intervention of swineherd for feeding and bedding. Space in the climatic chamber was divided into feeding-lying area and dunging area. The pigs was offered wet diet ad libitum, feed was humidizing by adjunctive water. In the experiment nipple drinker was used. Pigs had unlimited access to water and feed throughout the day. Urine and faeces were mucked out every day. Straw was delivered to lying area every day. The control group consisted of 6 pigs (3 ♀, 3 ♂), which were housed in pens. The floor surface area of the pen was divided into main two sectors, solid and slatted floor were used. Solid floor was made of agro brick. During the winter, the stall was heated. A wet feeder was situated at the front of the pen on lying area, pigs was offered also water and feed ad libitum. Feeding was controlled by computer program, which provided different mixture of components into each pen. Daylight was provided from 06:00 to 18:00 h. Pigs were regularly weighed and they were electrically stunned when they reached slaughter weight 100 kg. Following slaughter, carcasses were done according to standard practices. The traits of meat quality were examined in *Musculus longissimus thoracis* and *Musculus semimembranosus.* Ultimate pH was recorded 45 minutes and 24 hours *post mortem* using a portable pH-meter Sentron Titan X. Also the electric conductivity was measured 45 minutes and 24 hours after slaughter. Drip loss was measured 24 hours *post mortem* in slices stored horizontally. Samples intended for Warner–Bratzler shear force measurements were vacuum-packed at cutting and stored until analysis using device Chatillon. Meat colour of samples was measured 24 hours after slaughtering. The parameters *L*, a** and *b** representing lightness, redness and yellowness were recorded in the middle of each sample by spectrophotometer CM 2600 D.

Data were analysed using the standard statistical analysis. Effects of groups were tested by statistical program SAS.

Results and Discussion

Comparison of meat quality traits of pigs influenced by constant high ambient temperature and pigs housed in standard conditions of breed Large White in *Musculus longissimus thoracis* muscle did not show any statistically significant differences (Tab. 1.). According to Gregory (2010) and Van de Perre et al. (2010) rearing pigs in alternating high and low environmental temperatures caused paler meat and poorer quality compared to constant temperature. In our experiment parameter pH 45 minutes and 24 hours *post mortem* in MLT was lower in experimental group influenced by heat, than in control group what is in contrast with results reported by Lefaucheur et al. (1991) and

Table 1. Effect of high temperature on meat quality of pork in MLT

Trait	Experimental group n = 7	Control group n = 6
	x±SD	x±SD
pH 45 min	6,20±0,09	6,29±0,12
pH 24 h	5,65±0,09	5,70±0,04
Conductivity 45 min	3,21±0,36	3,13±0,67
Conductivity 24 h	6,57±2,67	6,35±1,73
Drip loss	6,57±2,75	6,00±2,83
Shear force	4,47±0,60	5,02±0,49
L *	57,87±1,28	55,86±2,75
a *	6,86±6,83	4,20±5,67
b *	3,76±8,74	7,71±6,22

* differences statistically significant at P ≤0,05, L – lighteness, a – redness, b – yellowness, SD – standard deviation

there was no occurrence of PSE syndrome. Hansen, Biensen (2009) and Mota-Rojas et al. (2006) found out that in hot season increased the incidence of lower pH compared to cool season what was showed in our results. Electric conductivity 45 minutes in MLT after slaughter was higher in group influenced by heat (3.21 vs. 3.1 mS^{-1}). Drip loss in MLT muscle was higher in experimental group (6.57 vs. 6.00 %) than in group housed in the pen. Compared with control, shear force in MLT was lower in experimental group. Pork meat affected by high temperature in MLT muscle was paler as assumed Dalla Costa et al. (2007) but there were no significant differences. Parameters *a** representing redness was lower in the pen and parameter *b** representing yellowness was higher in the pen.

Meat quality of pigs which were housed in climatic chamber with constant temperature (30 °C) and in the standard conditions of pen in muscle *Musculus semimembranosus* showed Tab. 2. According to results pH 45 minutes *post mortem* in MSM was lower in experimental group. It was found that meat of pigs influenced by high temperature in MSM had significantly lower (P ≤0.05) pH 24 hours after slaughter than in standard conditions (5.69 ±0.09 vs. 5.70 ±0.04). Rinaldo, Mourot (2001) compared the ultimate pH of muscles *longissimus dorsi* and *biceps femoris* and found out that pH was higher in the tropical climate than in cool climate. Electric conductivity of meat after 24 hours *post mortem* in MSM was significantly lower (P ≤0.05) in pigs housed in pen (11.67±0.32 mS^{-1} vs. 9.75±2.13 mS^{-1}). Parameter drip loss in MSM was higher in meat of pigs housed in conditions with higher temperature, which was also presented in experiment by Brown et al. (2012). Shear force was higher in experimental group. In parameter colour of meat, lighteness is most important, paler meat was found in experimental group influenced by heat in MSM what is consistent with previous studies of Dalla Costa et al. (2007), but there was no significant difference. Parameter *a** was higher in experimental group, parameter *b** lower in group housed in climatic chamber. Gregory (2010) and Van de Perre et al. (2010) reported, that high temperature increase the risks of PSE meat in pigs, but in our experiment it was not found any PSE meat in both muscles of pigs reared in conditions affected by heat. Comparing *Musculus longissimus thoracis* and *Musculus semimembranosus* muscles of pigs it was found that pH 45 minutes and 24 hours after slaughter was lower in MSM muscle than in MLT. Parameter conductivity 45 and 24, drip loss and shear force was higher in MSM. Lefaucher et al. (1991) reported that moisture loss was lower in *semispinalis* muscle than in *longissimus* muscle. Higher values of parameters *L*, a** and *b** represented lightness, redness and yellowness were showed in MSM muscle compared to MLT.

Table 2. Effect of high temperature on meat quality of pork in MSM

Trait	Experimental group n = 7	Control group n = 6	Significance
	x±SD	x±SD	
pH 45 min	6,15±0,05	6,18±0,07	
pH 24 h	5,59±0,06	5,67±0,04	*
Conductivity 45 min	5,80±0,52	6,50±0,70	
Conductivity 24 h	11,67±0,32	9,75±2,13	*
Drip loss	10,20±1,85	9,44±3,40	
Shear force	5,05±0,25	4,97±0,49	
L *	61,33±1,65	59,87±3,69	
a *	11,63±9,18	7,40±6,48	
b *	3,84±11,97	9,59±8,28	

* differences statistically significant at P ≤0,05, L – lighteness, a – redness, b – yellowness, SD – standard deviation

Conclusion

Given results showed that high temperature influenced meat quality of pork in some ways. Pigs influenced by heat had significantly lower pH 24 hours post mortem in MSM and also in MLT, but there was no statistically significant difference. Drip loss was higher in group housed in climatic chamber. It was found that electric conductivity 24 hours after slaughter in MSM was significantly lower in pigs housed in standard conditions. Meat of pigs affected by heat was paler.

References

BERG, E. P. Critical Points Affecting Fresh Pork Quality within the Packing Plant [online]. April 2010 [cit.2012-10-22]. Available from Internet: < http://www.extension.org/pages/31116/critical-points-affecting-fresh-pork-quality-within-the-packing-plant>

BROWN, J. et al. Effects of Transport Duration on the Stress Response and Pork Quality of Pigs Quality [online]. August 2012 [cit.2012-10-20]. Available from Internet: < http://www.thepigsite.com/articles/3983/effects-of-transport-duration-on-the-stress-response-and-pork-quality-of-pigs>

DALLA COSTA, O. A. et al. Effects of the season of the year, truck type and location on truck on skin bruises and meat quality in pigs. In *Livestock Science*, 2007, vol. 107, no. 1, pp. 29-36.

FAGUNDES A. C. A. et al. Influence of environmental temperature, dietary energy level and sex on performance and carcass characteristics of pigs. In *Brazilian Journal of Veterinary Research and Animal Science*, 2009, vol.46 no. 1, pp. 1385-1396.

GREGORY, N. G. How climatic changes could affect meat quality. In *Food Research International*, 2010, vol. 43, no. 7, pp. 1866-1873.

HANSEN, R. – BIENSEN, N. Effects of Ambient Temperature and Transportation Distances on the Resulting Pork Quality [online]. July 2009 [cit.2012-10-18]. Available from Internet: <http://www.thepigsite.com/articles/16/pig-meat-quality/2828/effects-of-ambient-temperature-and-transportation-distances-on-the-resulting-pork-quality>

LEFAUCHEUR, L. et al. Influence of environmental temperature on growth, muscle and adipose tissue metabolism, and meat quality in swine. In *Journal of Animal Science*, 1991, vol. 69, no. 7, pp. 2844-2854.

MOTA-ROJAS, D. et al. Effects of mid-summer transport duration on pre- and post-slaughter performance and pork quality in Mexico. In *Meat Science*, 2006, vol. 73, no. 3, pp. 404-412.

NARDONE, A. et al. Effects of climate changes on animal production and sustainability of livestock systems. In *Livestock Science*, 2010, vol. 130, no. 1-3, pp. 57-69.

RINALDO, D. – MOUROT, J. Effects of tropical climate and season on growth, chemical composition of muscle and adipose tissue and meat quality in pigs. In *Animal Research*, 2001, vol. 50, no. 6, pp. 507-521.

VAN DE PERRE, V. et al. Effect of unloading, lairage, pig handling, stunning and season on pH of pork. In *Meat Science*, 2010, vol. 86, no. 4, pp. 931-937.

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