

EFFECT OF EXTERNAL FACTORS BEFORE SLAUGHTER ON MEAT QUALITY OF PIGS

Mlynek J.¹, Imrich I.², Mlyneková E.¹

juraj.mlynek@uniag.sk

¹*Slovak University of Agriculture in Nitra, Department of Animal Husbandry, Slovakia*

²*Slovak University of Agriculture in Nitra, Department of Veterinary Sciences, Slovakia*

Abstract

For consumers as well as meat industry, it is important that the meat will be in good quality. Except genetic predisposition to stress, some changes of meat quality can be caused by stress before slaughter. The aim of the experiment was assess possible influence of pre-slaughter factors on pig meat quality. The meat quality of 1980 meat hybrids of fattening pigs was evaluated. The following pre-slaughter indicators were evaluated: month of slaughter, time of loading, time of transport, time of housing, temperature during housing and time of slaughter. The meat quality was judged on the basis of the pH value measured 45 minutes after the slaughter of animals (pH₁). We found out that the meat quality was influenced by month of slaughter. The highest incidence of PSE (pale, soft, exudative) meat in the MLD - *musculus longissimus dorsi* was found on July. The lowest average pH₁ in the MLD was found out on February, it was statistically significant (P<0.05) in comparison with other month. The highest incidence of PSE meat in relation to time of loading was detected in 0, 11, 12 a.m. and from 4 to 6 p.m. In the indicator time of slaughter was found out the highest incidence of PSE meat in hours from 3 a.m. to 9 a.m. Duration of transport to the slaughterhouse was maximally 2 hours. The lowest incidence of PSE meat was found out in the groups of pigs which were housed in the slaughterhouse from 1 to 4 hours. In conclusion we can state that the meat quality was markedly influenced of pre-slaughter factors.

Key Words: pH MLD, pre-slaughter factors, transport, temperature

In this time in meat production is preferred quantity over quality in Slovakia. Therefore is very important for the consumers as well as for the meat industry that meat fulfils such quality indicators as physical and chemical requirements, sensory, hygienic, microbiological and technological factors of meat quality. Some changes of meat quality can be caused mainly by stress and by the genetic predisposition to stress. The quality of pork is the result of a production system, as the combination of genetic, rearing condition, age and weight at slaughter, handling, stress (Majorano et al., 2012), health (Rolinec et al., 2010), as well as cooking method (Sinha et al., 2009). Demo (2002) states that quality meat indicators are the features of low heredity and that the final quality of raw material mostly depends on the conditions of the outside environment, especially on the conditions before, during and after slaughter. Pre-slaughter stress is generally thought to be of some influence on meat quality parameters, mostly with a negative effect (Küchenmeister et al. 2002). Transportation conditions such as noise, loading and unloading, fighting due to the mixing of unfamiliar pigs and stocking too many animals in a truck mean severe stress for the animal resulting in an accelerated post-mortem glycolysis and impaired meat quality (Smulders, van Laack, 1991). Pulkrábek et al. (2003) claim that PSE meat detection is fairly complicated and that this is the reason why its coincidental occurrence is often deduced from the common practice based on the pH₁ values. The given pH₁ values will be stated 45 – 60 minutes after the animal slaughter. If the measurement

achieves the value of 5.8 and less, it points to an eventual mistake, which is the PSE meat. The aim of the experiment was to assess influence of pre-slaughter factors (month of slaughter, time of loading, time of slaughter, duration of transport and housing) on pig meat quality of fattening pigs.

Material and Methods

In the experiment, the meat quality of 761 pigs was evaluated. The meat hybrid pigs that were tested in the experiment were the crossbred of the White thoroughbred and Landrace pig breeds with the terminal, extremely heavy- muscled hogs. Their weight went from 100 to 130 kg. The following pre-slaughter indicators were evaluated: month of slaughter, time of loading during a day in hours, duration of transport in hours, duration of housing in hours, time of slaughter during a day in hours, outdoor temperature during housing in °C. The animals were divided in to the four groups according to month of slaughter: January, February, May and July. The animals were divided in to the ten groups according to time of loading during a day: 0, 4, 9, 10, 11, 12, 15, 16, 17 and 18. The animals were divided in to the nine groups according to time of slaughter during a day: 3, 4, 5, 6, 7, 8, 9, 11 and 13. The animals were divided in to the eleven groups according to duration of housing: 1, 2, 4, 7, 8, 10, 11, 13, 14, 16 and 17. Duration of transport within all evaluated pigs was similar and took maximum two hours. The meat quality was judged on the basis of the pH value measured

45 minutes after the slaughter of animals. Measuring the acidity rate in the carcass halves was observed in the thorax part of the longest back muscle between the next to last and the last breast vertebrae (*musculus longissimus dorsi, pars thoracis* – MLD) and from the geometric center of the semimembranous thigh muscle (*musculus semimembranosus* – MSM). The actual pH acidity in muscles was stated directly in the muscle tissue by means of the contact electrode, the TITANx apparatus. The method measuring the pH value 45 minutes after slaughter enable to identify the PSE meat (pale-, soft-, exudative), if the pH value falls down below 5.8 (Demo 2002). The results were processed in the SPSS programme. Differences between groups were tested using analysis of variance with contrasts testing using Tukey HSD test.

Results and Discussion

Evaluated pigs were slaughtered in the months of January, February, May and July. The highest average value of pH₁ MLD (6.21) was found out in the group of pigs slaughtered in February, compared with the other groups, this difference was statistically significant (P<0.05). In groups of pigs with a lower average value of pH₁ MLD (slaughtered in January, May and July) were recorded the highest incidence of PSE meat in MLD, at the level 31.03 to 34.00 %. The high incidence of PSE meat in May and July could be caused by high average daily temperatures (19.22 °C and 25.30 °C). Higher values were found out in pH₁ MSM and differences between groups were not statistically significant. The incidence of PSE meat in the MSM were on the level from 11.11 to 17.00 % (table 1).

Depending on the time of loading during a day, the highest incidence of PSE meat was at midnight and between the 11-th hour and 18-th hour. The highest average value of pH₁ MLD was found out in the groups,

which were loaded at 9 and 10 hour, this was statistically significant (P<0.05) compared with other groups. A similar trend was also in the MSM. The highest outdoor temperatures during housing were recorded in the 0th, 4th, 15th, 17th, 18th hour (table 2). Ritter et al. (2008) also addressed the annual period of physical indicators of stress during loading, unloading and transport of pigs. Stated that physical indicators of stress is increased after long transport distances and higher values of these parameters observed unloading pigs.

The highest percentage of PSE meat in MLD depending on the time of slaughter was recorded in groups from the 3rd to the 9th hour. The incidence of PSE at this time was in the MLD from 14.49 to 44.16 %. The lowest incidence of PSE meat in MLD was recorded in the 11th and 13th hour of slaughter. In this time there was recorded the lowest average outdoor temperature during housing (-0.27 °C and -0.90 °C). The incidence of PSE meat in the MSM was also the highest from the 4th to 8th hour of slaughter. The highest average pH₁ MLD and MSM values were in the groups of pigs slaughtered at the 11th and the 13th hour, these values were significantly higher compared with the other groups of pigs (table 3). Lammens et.al. (2007) notes that the meat quality differences were found in relation to different slaughterhouses but also according to the type of muscle and measurement time. Animals used in the experiment have been transported maximum to 2 hours. Werner et al. (2007) found out that short transport may have an impact on animal welfare as well as the long transport. Chai et al. (2010) found out that increasing transportation time increases drip loss water. Significant differences found out for the animals from which traffic exceeding 40 minutes as well as in animals transported 3 till 5 hours. Pilcher et al. (2011) found out that the presence of dead or injured pigs affects driving time and space in which animals are transported.

Table 1. Meat quality of fattening pigs in relation to month of slaughter

Month	Number	pH ₁ MLD	% PSE MLD	pH ₁ MSM	% PSE MSM	OAT	OMT
1	145	6.02±0.29 ^a	31.03	6.26±0.33	13.79	2.00	4.00
2	246	6.21±0.28 ^b	10.98	6.24±0.34	14.63	-0.10	1.78
5	270	5.95±0.23 ^a	31.11	6.23±0.30	11.11	19.22	26.33
7	100	5.95±0.24 ^a	34.00	6.17±0.29	17.00	25.30	33.50
Total	761	6.05±0.29	24.97	6.23±0.32	13.53	10.49	15.08

% PSE MLD – incidence of PSE meat in *musculus longissimus dorsi*, % PSE MSM – incidence of PSE meat in *musculus semimembranosus*, OAT - outdoor average temperature during housing, OMT - outdoor maximum temperature during housing

a,b - P<0,05

Table 2. Meat quality of fattening pigs in relation to time of loading during a day

Time of loading	Number	pH ₁ MLD	% PSE MLD	pH ₁ MSM	% PSE MSM	OAT	OMT
0	58	5.85±0.21 ^a	44.83	6.23±0.27 ^a	5.17	20.10	27.30
4	64	6.10±0.23 ^c	9.38	6.31±0.30 ^{a,b}	9.38	24.41	31.51
9	66	6.37±0.25 ^d	3.03	6.44±0.26 ^b	3.03	-0.90	2.00
10	49	6.28±0.23 ^d	4.08	6.29±0.28 ^{a,b}	4.08	0.20	1.70
11	93	6.00±0.29 ^{b,c}	34.41	6.26±0.35 ^a	15.05	2.00	4.00
12	74	6.01±0.28 ^{b,c}	29.73	6.20±0.32 ^a	18.92	6.52	10.09
15	44	6.08±0.18 ^c	11.36	6.25±0.36 ^a	15.91	17.20	24.50
16	180	6.06±0.28 ^c	23.89	6.16±0.33 ^a	20.56	5.62	8.67
17	78	5.91±0.18 ^{a,b}	34.62	6.15±0.23 ^a	11.54	18.98	26.43
18	55	5.89±0.25 ^{a,b}	45.45	6.17±0.32 ^a	16.36	25.30	33.50
Total	761	6.05±0.29	24.97	6.23±0.32	13.53	10.49	15.08

% PSE MLD – incidence of PSE meat in *musculus longissimus dorsi*, % PSE MSM – incidence of PSE meat in *musculus semimembranosus*, OAT - outdoor average temperature during housing, OMT - outdoor maximum temperature during housing

a,b,c,d - P<0,05

Table 3. Meat quality of fattening pigs in relation to time of slaughter during a day

Time of slaughter	Number	pH ₁ MLD	% PSE MLD	pH ₁ MSM	% PSE MSM	OAT	OMT
3	53	5.87±0.15 ^a	41.51	6.15±0.21 ^a	7.55	16.00	23.10
4	93	6.00±0.29 ^{a,b}	34.41	6.26±0.35 ^{a,b}	15.05	2.00	4.00
5	49	5.90±0.22 ^a	40.82	6.24±0.29 ^{a,b}	10.20	20.10	27.30
6	77	5.89±0.23 ^a	44.16	6.14±0.33 ^a	22.08	22.99	30.93
7	203	6.09±0.27 ^b	19.70	6.17±0.33 ^a	20.20	3.13	5.42
8	69	6.05±0.19 ^b	14.49	6.21±0.34 ^{a,b}	17.39	20.13	27.76
9	102	5.98±0.26 ^{a,b}	27.45	6.29±0.30 ^{a,b,c}	5.88	21.78	28.72
11	30	6.36±0.27 ^c	6.67	6.45±0.27 ^c	6.67	-0.90	2.00
13	85	6.32±0.24 ^c	2.35	6.35±0.27 ^{b,c}	2.35	-0.27	1.83
Total	761	6.05±0.29	24.97	6.23±0.32	13.53	10.49	15.08

% PSE MLD – incidence of PSE meat in *musculus longissimus dorsi*, % PSE MSM – incidence of PSE meat in *musculus semimembranosus*, OAT - outdoor average temperature during housing, OMT - outdoor maximum temperature during housing

a,b,c - P<0,05

The highest incidence of PSE meat in MLD and MSM was detected in the groups of pigs lairaged from 7 to 17 hours in the slaughterhouse. The highest average values of pH₁ in the MLD and MSM were recorded in pigs housed in a slaughterhouse from 1 to 4 hours and were statistical significant in comparison with other groups (P<0.05). This implies that prolonging of housing time deteriorated quality of pig meat (table 4).

D'Eath et al. (2010) notes that pre-slaughter stress has a negative impact on animal welfare and meat quality. Aggressive behavior after mixing pigs in transport or on

arrival at the slaughterhouse is an important factor in the pre-movement stress. Śmiecińska et. al. (2011) notes that pigs slaughtered immediately after transport, compared with those who were slaughtered after 24 hours of good rest, have a higher meat content in the carcass. Handling prior to slaughter had no effect on the quality of pig meat. The incidence of normal quality meat and meat PSE was the same in both treatment groups. In contrast to our findings the authors Gentry et al. (2002) indicate that pigs do not show the value of PSE meat when they are in a slaughterhouse lairage enough time to rest before slaughter

Table 4. Meat quality of fattening pigs in relation to duration of housing in slaughterhouse

Housing duration	Number	pH ₁ MLD	% PSE MLD	pH ₁ MSM	% PSE MSM	OAT	OMT
1	30	6.36±0.27 ^c	6.67	6.45±0.27 ^d	6.67	-0.90	2.00
2	105	6.26±0.26 ^{d,e}	5.71	6.32±0.27 ^{b,c,d}	4.76	4.60	7.86
4	44	6.15±0.23 ^{c,d}	4.55	6.37±0.31 ^{c,d}	6.82	24.00	30.60
7	58	5.85±0.21 ^a	44.83	6.23±0.27 ^{a,b,c}	5.17	20.10	27.30
8	53	5.87±0.15 ^{a,b}	41.51	6.15±0.21 ^{a,b}	7.55	16.00	23.10
10	55	5.89±0.25 ^{a,b}	45.45	6.17±0.32 ^{a,b,c}	16.36	25.30	33.50
11	49	5.90±0.22 ^{a,b}	40.82	6.24±0.29 ^{a,b,c}	10.20	20.10	27.30
13	131	6.11±0.27 ^{c,d}	17.56	6.12±0.35 ^a	24.43	0.20	1.70
14	25	6.00±0.20 ^{a,b,c}	20.00	6.14±0.29 ^{a,b}	20.00	25.30	33.50
16	137	6.03±0.26 ^{b,c}	27.01	6.26±0.35 ^{a,b,c,d}	15.33	6.88	10.58
17	74	6.01±0.28 ^{b,c}	29.73	6.20±0.32 ^{a,b,c}	18.92	6.52	10.09
Total	761	6.05±0.29	24.97	6.23±0.32	13.53	10.49	15.08

% PSE MLD – incidence of PSE meat in *musculus longissimus dorsi*, % PSE MSM – incidence of PSE meat in *musculus semimembranosus*, OAT - outdoor average temperature during housing, OMT - outdoor maximum temperature during housing

a,b,c,d,e - P<0,05

Conclusion

The analyses were conducted on 761 pigs. We can state that influence of slaughter month was most reflected in the incidence of PSE meat in the MLD in the 1st, 5th and 7th month. Time of loading had the largest impact on the high incidence of PSE meat in the MLD and the MSM at the time of the 11th to the 18th hour. Time of slaughter in a slaughterhouse had the most influence on high incidence of PSE meat in MLD and MSM from the 3rd to the 9th hour. Time of housing at the slaughterhouse had a significant impact on the incidence of PSE meat in MLD and MSM. The longer the animals were housed (7-17 hours) the more deteriorated the quality of the meat. So it is best to slaughter pigs immediately with the arrival to 1 to 4 hours. On the slaughterhouse were not created conditions for rest pigs (mixed groups, slippery floors, noise, etc.) and therefore the length of pig housing deteriorated meat quality.

References

- Chai J., Xiong Q., Zhang C.X., Li F.E., Zheng R., Peng J., Jiang S.W. (2010): Effect of pre-slaughter transport plant on blood constituents and meat quality in halothane genotype of NN Large White×Landrace pigs. In *Livestock Science*, vol. 127, issues 2-3, pp. 211-217.
- D'Eath R. B., Turner S. P., Kurt E., Evans G., Thoelking L., Looft H., Wimmers K., Murani E., Klont R., Foury A., Ison S. H., Lawrence A. B., Mormede P. (2010): Pigs' aggressive temperament affects pre-slaughter mixing aggression, stress and meat quality. In *Animal*, vol. 4(4), pp. 604-616.
- Demo P. (2002): *Sprievodca chovateľa hospodárskych zvierat*. Nitra:VÚŽV, 2002, p. 134, ISBN 80-88872-18-9.
- Gentry J. G., McGlone J. J., Blanton J.R., Miller M. F. (2002): Impact of spontaneous exercise on performance, meat quality, and muscle fiber characteristics of growing/finishing pigs. In *Journal of Animal Science*, vol. 80, no.11, pp. 2833-2839.
- Küchenmeister U., Kuhn G., Stabenow B., Ender K. (2002): The effect of experimental stress on sarcoplasmic reticulum Ca²⁺ transport and meat quality in pig muscle. In *Meat Science*, No. 61, pp. 375-380.
- Lammens V., Peeters E., De Maere H., De Mey E., Paelinck H., Leyten J., Geers R. (2007) : A survey of pork quality in relation to pre-slaughter conditions, slaughterhouse facilities, and quality assurance. In *Meat science*, vol. 75, issue 3, pp. 381-387.
- Majorano G., Kapelański W., Bocian M., Pizzuto R., Kapelańska J. (2012): Influence of rearing system, diet and gender on performance, carcass traits and meat quality of Polish Landrace pigs. In *Animal*, Press online.
- Pilcher C.M., Ellis M., Rojo S., Gomez A., Curtis S.E., Wolter B.F., Peterson C.M., Peterson B.A., Ritter M.J., Brinkmann J. (2011): Effects of floor space during transport and journey time on indicators of stress and transport losses of market-weight pigs. In *Journal of Animal Science*, vol. 89, issue 11, pp. 3809-3818.
- Pulkrábek J., Pavlík J., Vališ L. (2003): Kvalita mäsa s ohľadom na mäsnatosť ošipaných. In *Slovenský chov*, vol. 8, 2003, No. 6, p. 26, ISSN 1335-1990.

- Ritter, M.J., Ellis, M. – Bowman, R., Brinkmann, J., Curtis, S.E., DeDecker, J.M., Mendoza, O., Murphy, C.M., Orellana, D.G., Peterson, B.A., Rojo, A., Schlipf, J.M., Wolter, B.F. (2008): Effects of season and distance moved during loading on transport losses of market-weight pigs in two commercially available types of trailer. In *Journal of Animal Science*, vol. 86, issue 11, pp. 3137-3145.
- Rolinec M., Biro D., Šťastný P., Kanka T. (2010): Zhodnotenie hematologických ukazovateľov prasiat v skorom postnatálnom období - Analyzis of haematological profile of piglets in early postnatal period. In *Acta fytotechnica et zootechnica*, vol. 13, 2010, pp. 40-43, ISSN 1335-258X.
- Sinha R., Park Y., Graubard B.I., Leitzmann M.F., Hollenbeck A., Schatzkin A., Cross A.J. (2009): Meat and meat-related compounds and risk of prostate cancer in a large prospective cohort study in the United States. In *American Journal of Epidemiology*, 170(9), pp. 1165-1177.
- Smiecinska K., Denaburski J., Sobotka W. (2011): Slaughter value, meat quality, creatine kinase activity and cortisol levels in the blood serum of growing-finishing pigs slaughtered immediately after transport and after a rest period. In *Polish Journal of Veterinary Sciences*, vol. 14, issue 1, pp. 47-54.
- Smulders F.J.M., van Laack H.L.J.M. (1991): Pre-slaughter animal handling and fresh meat processing. In *Proceedings 37th International Congress Meat Science Technology*, September 1-6, 1991, Kulmbach, Germany, pp.213-219.
- Werner C., Reiners K., Wicke M. (2007): Short as well as long transport duration can affect the welfare of slaughter pigs. In *Animal Welfare*, vol. 16, issue 3, pp. 385-389.

This article has been created by the execution of the Project "Excellence Centre of the Protection and Utilization of Agro biodiversity, the Operational Programme: 2620002 OP Research and Development, code of the ITMS project: 26220120032", is based on the support of the Operational Programme Research and Development, funded by the European Fund for Regional Development and with the support of VEGA 1/0493/12-Qualitative and production parameters of animal with regard to pre-slaughter factors, nutrition, technique and breeding technology.