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THE EFFECT OF TEMPERATURE DURING TRANSPORTATION TO THE QUALITY OF PORK

*Juraj Mlynek**[1], *Ivan Imrich*[2], *Eva Mlyneková*[1]

Address(es): prof. Ing. Juraj Mlynek, CSc.
[1]Slovak University of Agriculture, Faculty of Agrobiology and Food Resources, Department of Animal Husbandry, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic, phone number: +421 37 641 4410.
[2]Slovak University of Agriculture, Faculty of Agrobiology and Food Resources, Department of Veterinary Sciences, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic.

*Corresponding author: juraj.mlynek@uniag.sk

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ABSTRACT

The aim of the experiment was to assess the impact of different temperature during transportation on the pork quality. Two thousand eleven commercial pigs hybrids, weighing 100-130 kg were used in the experiment. Acidity of meat and muscle temperature were assessed 45 minutes after slaughter in the longest back muscles between the next to last and last *thoracic vertebrae (musculus longissimus dorsi, pars thoracis)* – pH_1 MLD and T MLD, and in the geometric center *semimembranosus* thigh muscle *(musculus semimembranosus)* – pH_1 MSM and T MLD. Pigs were divided into groups according to the temperature during housing in slaughterhouse using quartile distribution. Experiment results show that increase of average daily temperature during the transport resulted in worse quality of meat in MLD which was shown in pH_1 MLD decrease and the temperature MLD increase. More significant pH_1 (5.97) decrease occurred during average daily temperature higher than 15.0 °C and at this temperature the most significant temperature increase occurred in MLD muscle. Also the pH_1 MSM indicator showed decrease in average values due to average outer temperature increase. The lowest pH_1 MSM (6.22) value was detected in the group with average daily temperature during transport above 15 °C. Lower pH_1 values were detected in *musculus longissimus dorsi.*

Keywords: Acidity of meat, pork, temperature, transport

INTRODUCTION

The total meat consumption in the world in continuously rising and in global average approaches 42 kg per person annually. Pork meat dominates in consumption which represents 38-40 % of the total market **(Pažout 2010)**. At the present, the number of consuments is growing, those who look for quality articles of food **(Václavková and Lustiková, 2010)**. For the consumers as well as for the meat industry, it is very important that the pork will be in good quality **(Šprysl *et al.*, 2010)**. The quality of pork is the result of a production system, such as the combination of genetic, rearing condition **(Hluchý and Eliáš, 2006; Hluchý *et al.*, 2007)**, age and weight at slaughter, handling, stress **(Majorano *et al.*, 2012)**, health **(Rolinec *et al.*, 2010; Kanka *et al.*, 2014)**, as well as cooking method **(Sinha *et al.*, 2009)**. Transportation conditions such as ambient temperature, humidity, 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 and Van Laack, 1991; Andersen *et al.*, 2005)**. The reaction organism to stress triggers increased glycolysis which occurs mainly after slaughter, which results in fast production of lactacid at high temperature immediately after slaughter. The result is meat which is significantly pale and exudative **(Martinez-Rodriguez *et al.*, 2011)**. From the view point of meat quality, the greatest problem is occurrence of PSE defect **(Václavková and Lustikova, 2010)**. **Pulkrábek *et al.* (2003)** claim that pork quality detection is fairly complicated and that this is the reason why it is often deduced in the common practice based on the pH_1 values. During inappropriate weather conditions (high air humidity and high temperature) it is necessary to secure the optimal conditions in inner truck spaces used for pig transport **(Gade *et al.*, 2007)**. The aim of the experiment was to assess the impact of different temperature during transportation on the pork quality.

MATERIAL AND METHODS

Two thousand eleven commercial pigs hybrids, weighing 100-130 kg were used in the experiment. Influence of the average external temperature on the pork quality was evaluated during transport. Pigs were divided into four groups according to the average daily outer temperature during pigs transport to slaughterhouse using quartile distribution. Based on this distribution, the following groups were created: S1 with value up to 1.6 °C; S2 with value above 1.6 up to 9.9 °C; S3 with value above 9.9 up to 15 °C and group S4 above 15.0 °C. Acidity and temperature of meat was assessed 45 minutes after slaughter in the *longissimus muscle* between the next to last and last thoracic vertebrae *(musculus longissimus dorsi, pars thoracis)* – pH_1 MLD and T MLD in °C, and in the geometric center semimembranosus thigh muscle *(musculus semimembranosus)* – pH_1 MSM and T MSM in °C. The right side of the carcass was used to perform meat quality measurements. Muscle pH and muscle temperature *post mortem* were measured using a portable apparatus TITAN x.

Statistical Analysis

The results were processed in the SPSS 11.0 program. Following variables - statistical values were calculated: minimum, maximum, arithmetic mean, standard deviation - S.D., variation coefficient in % - VC %. Differences between groups were tested using analysis of variance with contrast testing using Tukey HSD test.

RESULTS AND DISCUSSION

Table 1 shows comparison of variation-statistical pH_1 MLD values in relation to average daily temperature during pigs transport to slaughterhouse. Significantly the highest mean pH_1 MLD ($P<0.01$) value was in pig groups transported during average daily temperatures up to 9.9 °C (groups S1 and S2). With the increase of average daily temperature the pH_1 MLD values decreased. Significantly the lowest pH_1 MLD value ($P<0.01$) was detected in group S4 (5.97). The significance of results in muscle MLD temperature (Tab. 2) was detected at the $P<0.01$ level between groups S1 and S4, S2 and S3, S2 and S4, S3 and S4 and at the level $P<0.05$ between groups S1 and S2. Variability at this indicator was from 9.12 to 11.72 %. Based on these data we can state that with the increase of average daily temperature during transport, the meat quality worsened in MLD, which was expressed in significant pH_1 in MLD decrease and by temperature rise in MLD. The most significant pH_1 decrease occurred at average daily temperature higher than 15.0 °C and at this temperature occurred the most significant increase in muscle MLD temperature. Apart from listed results,

Brandt *et al.* (2013) found higher mean pH_1 values in *musculus longissimus dorsi*. pH_1 values were at the level 6.7 up to 6.8. Pigs came from four commercial hog breeding farms and were transported at average daily temperature in a truck at 14.8±1.8 °C.

Table 1 Comparison of variation-statistical pH_1 MLD values in relation to average outer temperature during pigs transport

group	n	minimum	maximum	mean	S.D.	CV %
S1	546	5.4	6.8	6.16	0.30	4.87
S2	464	5.4	6.9	6.16	0.29	4.71
S3	565	5.4	6.7	6.10	0.27	4.45
S4	436	5.4	6.7	5.97	0.24	4.04

Legend: Statistically significant differences – S1:S3 (P<0.01); S1:S4 (P<0.01); S2:S3 (P<0.01); S2:S4 (P<0.01); S3:S4 (P<0.01)

Table 2 Comparison of variation-statistical values T MLD in relation to outer average temperature during pigs transport

group	n	minimum	maximum	mean	S.D.	CV %
S1	546	17.6	32.3	26.24	2.66	10.12
S2	464	15.4	32.7	25.77	3.02	11.72
S3	565	17.8	33.0	26.54	2.58	9.73
S4	436	20.2	33.2	27.82	2.54	9.12

Legend: Statistically significant differences – S1:S2 (P<0.05); S1:S4 (P<0.01); S2:S3 (P<0.01); S2:S4 (P<0.01); S3:S4 (P<0.01)

Also in pH_1 MSM indicator (Tab. 3) was detected decline in average values by the effect of rising average daily temperature. The lowest pH_1 MSM value (6.22) was detected in S4 group with average daily temperature during transport over 15 °C. Statistically significant differences in pH_1 MSM were confirmed between groups S3 and S4 (P<0.01) and groups S1 and S3, S2 and S3 (P<0.05). In table 4 are listed variation-statistical T MSM values. The lowest MSM temperature (26.13) was in group of pigs transported at average daily temperatures from 1.6 to 9.9 °C (S2). The highest MSM temperature was detected in group S4 (average daily temperatures over 15 °C). Statistically significant differences in MSM temperature were at the level P<0.01 between groups S1 and S2, S1 and S4, S2 and S3, S2 and S4 and also S3 and S4.

Table 3 Comparison of variation-statistical pH_1 MSM values in relation to average outer temperature during pigs transport

group	n	minimum	maximum	mean	S.D.	CV %
S1	546	5.4	6.9	6.25	0.34	5.47
S2	464	5.4	6.9	6.25	0.34	5.40
S3	565	5.4	6.9	6.31	0.33	5.25
S4	436	5.4	6.9	6.22	0.30	4.85

Legend: Statistically significant difference: S1:S3 (P<0.05), S2:S3 (P<0.05), S3:S4 (P<0.01)

Table 4 Comparison of variation-statistical T MSM values in relation to outer average temperature during pigs transport

group	n	minimum	maximum	mean	S.D.	CV %
S1	546	17.9	31.3	26.77	2.55	9.52
S2	464	16.0	32.6	26.13	2.86	10.97
S3	565	19.0	33.0	26.96	2.49	9.22
S4	436	21.7	33.6	28.23	2.40	8.52

Legend: Statistically significant differences: S1:S2 (P<0.01), S1:S4 (P<0.01), S2:S3 (P<0.01) S2:S4 (P<0.01), S3:S4(P<0.01)

From the listed analyses of average daily outer temperatures during transport to slaughterhouse and pH_1 MLD and MSM values is obvious that more significantly reacted to outer temperature muscle MLD than MSM. Muscle MLD and MSM temperature increased in both muscle groups in relation to outer temperature. In contrast to our results, **Van de Perre *et al.* (2010)** found significant higher pH_1 in summer than in spring or autumn. As a result, a significant lower prevalence of PSE meat was found in summer. **Gajana *et al.* (2013)** did not report relationships between transportation time, distance, stocking density, temperature and lairage time and technological quality attributes (pH ultimate) of pork. **Kameník and Steinhauser (2012)** list that PSE occurrence in meat is greater in summer than in winter because pigs do not have sweat glands in the skin and therefore they are more sensitive to higher temperatures which can act as stress factor. According to **Václavková and Lustyková (2010)** transport during summer season increase the risk of PSE meat occurrence up to twofold. Similarly **Guàrdia *et al.* (2004)** stated that the PSE prevalence is expected to be higher in summer. 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 **(Guàrdia *et al.*, 2004; Santos *et al.*, 1997; Warriss, 1991)**. The ambient temperature at 7:00 a.m. in the summer months, especially in June, July and August during road transport is higher than 15°C, thus negatively affecting the level of welfare and the number of pigs dying during transport to the slaughterhouse **(Vecerek *et al.*, 2006)**. These contentions are in accordance with our findings because growing average outer temperature statistically significantly affected the decline of pH_1 values in MLD and increase of muscle MLD and MSM temperature.

CONCLUSION

Before the slaughter, various stressors affect the pork meat quality. Stressful can become also high temperature during transport. From the experiment results emerged that the most appropriate transport of pigs should occur at the temperature of less than 15 °C. During average daily temperature over 15 °C, the meat quality can worsen which will become evident by decrease of pH_1 MLD and MSM values and simultaneously by increase of temperature in mentioned muscles. *Musculus longissimus* reacted more sensitively to higher outer temperature of environment during transport.

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REFERENCES

ANDERSEN, H.J., OKSBJERG, N., YOUNG, J.F., THERKILDSEN, M. 2005. Feeding and meat quality — a future approach. *Meat Science*. 70(3), 543–554.http://dx.doi.org/10.1016/j.meatsci.2004.07.015

BRANDT, P., ROUSING, T., HERSKIN, M.S., AASLYNG, M.D. 2013. Identification of post-mortem indicators of welfare of finishing pigs on the day of slaughter. *Livestock Science* 157(2-3), 535–544. http://dx.doi.org/10.1016/j.livsci.2013.08.020

GUÀRDIA, M. D., ESTANY, J., BALASCH, S., OLIVER, M. A., GISPERT, M., DRIESTRE, A. 2004. Risk assessment of PSE condition due to pre-slaughter conditions and RYR1 gene in pigs. *Meat Science*, 67(3), 471–478. http://dx.doi.org/10.1016/j.meatsci.2003.11.020

GADE P.B. - CHRISTENSEN L. - BALTZER M. - PETERSEN J.V. 2007. Causes of pre-slaughter mortality in Danish slaughter pigs with special emphasis on transport. In *Animal Welfare*, 16(4), 459-470.

GAJANA, C.S., NKUKWANA, T.T., MARUME, U., MUCHENJE, V. 2013. Effects of transportation time, distance, stocking density, temperature and lairage time on incidences of pale soft exudative (PSE) and the physico-chemical characteristics of pork. *Meat Science*, 95 (3), 520–525.http://dx.doi.org/10.1016/j.meatsci.2013.05.028

HLUCHÝ, S., ELIÁŠ, Z. 2006 Differences in musculus semimembranosus structure between pure breed and hybrid pigs. *Scientifical Papers Animal Sciences and Biotechnologies*, 39(1), 221-226.

HLUCHÝ, S., ELIÁŠ, Z., TOMAN, R. 2007 Histological structure of *musculus longissimus dorsi* in pigs with the same ryanodine receptor genotype (CC)in relation to feeding indicators. *Scientifical Papers Animal Sciences and Biotechnologies*, 40(1), 361-368.

KAMENÍK, J., STEINHAUSER, L. 2012. PSE, DFD and other meat quality defects. *Maso*, 23(6)., 57-61, ISSN 1210-4086.

KANKA, T., ROLINEC, M., BÍRO, D., ŠŤASTNÝ., P. 2014. Analýza pasívnej imunizácie prasiatok v postnatálnom období. SUA:Nitra, 164, ISBN 978-80-552-1181-7.

MAJORANO, G., KAPELAŃSKY, 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. *Animal*, 7(2), 341-347. http://dx.doi.org/10.1017/S1751731112001516

MARTINEZ-RODRIGUEZ, R., ROLDAN-SANTIAGO, P.,FLORES-PEINADO, S., RAMIREZ-TELLES, J. A., MORA-MEDINA, P., TRUJILLO-ORTEGA, M. E., GONZALES-LOZANO, M., BECERRIL-HERRERA, M., SANCHEZ-HERNANDEZ, M., MOTA-ROJAS, D. 2011. Deterioration of pork quality due to the effects of acute ante mortem stress: An Overview. *Asian Journal of Animal and Veterinary Advances*, 6(12), 1170-1184. ISSN 1683-9919. http://dx.doi.org/10.3923/ajava.2011.1170.11784

PAŽOUT, V. 2010. Chov prasat a produkce vepřového v EU. *Maso*, 21(2), 47-49, ISSN 1210-4086.

PULKRÁBEK, J., PAVLÍK, J., VALIŠ, L. 2003. Kvalita mäsa s ohľadom na mäsnatosť ošípaných. *Slovenský chov*, 8(6), 26.

ROLINEC, M., BÍRO, D., ŠŤASTNÝ, P., KANKA, T. 2010. Analyzis of haematological profile of piglets in early postnatal period. *Acta fytotechnica et zootechnica*, 13(special), 40-43.

SANTOS, C., ALMEIDA, J. M., MATIAS, E. C., FRAQUEZA, M. J., ROSEIRO, C., & SARDINAH, L. 1997. Influence of lairage environmental conditions and resting time on meat quality in pigs. *Meat Science*, 45(2), 253−262. http://dx.doi.org/10.1016/S0309-1740(96)00048-4

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. *American Journal of Epidemiology*, 170(9), 165-1177. http://dx.doi.org/10.1093%2Faje%2Fkwp280

SMULDERS, F. J. M., VAN LAACK, H. L. J. M. 1991. Pre-slaughter animal handling and fresh meat processing. Proceedings 37th International Congres Meat Science Technology. Kulmbach, Germany, September 1-6.

ŠPRYSL, M., ČÍTEK, J., STUPKA, R. 2010. Interaction of selected production indicators of the economics of pork production. *Czech Journal of Animal Science*, 55(1), 1-10.

VÁCLAVKOVÁ, E., LUSTYKOVÁ, A. 2010. Faktory ovlivňující kvalitu vepřového masa. *Náš chov*, 70(7), 32-33, ISSN 0027-8068.

VAN DE PERRE, V., PERMENTIER, L., DE BIE, S., VERBEKE, G., GEERS, R. 2010. Effect of unloading, lairage, pig handling, stunning and season on pH of pork. *Meat science*, 86(4), 931-937. http://dx.doi.org/10.1016/j.meatsci.2010.07.019

VECEREK, V., MALENA, M., MALENA JR., M., VOSLAROVA, E., CHLOUPEK, P. 2006. The impact of the transport distance and season on losses of fattened pigs during transport to the slaughterhouse in the Czech Republic in the period from 1997 to 2004. *Veterinarni Medicina*, 51(1), 21–28 .

WARRISS, P. D. 1991. A note on the influence of ambient temperature at slaughter on pig meat quality. Proceedings of the 37th international congress of meat science and technology. Kulmbach, Germany, 301-304.