ANALYSIS OF PORK QUALITY OF PIGS MANGALITZA BREED FATTENED TRADITIONAL FARMING SYSTEM COMPARED TO PIGS OF LARGE WHITE BREED FATTENED CONVENTIONAL WAY OF FARMING

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Abstract

The aim of our experiment was to determine and analyze parameters of physical and technological quality and chemical composition of pork meat in indigenous breed reared in traditional farming system in comparison with improved breed reared in conventional farming method. The experiment was realized at two different locations. The group of pigs reared in conventional rearing system were fattened in the testing conditions of Experimental Center for Livestock. There were 10 Large White Breed pigs used in this group which were housed and fattened in standard way. The group of pigs that were reared in alternative farming system were fattened at the University Farm Žirany. There were 20 Mangalitza Breed pigs used in this group which were housed in group pens on solid floor with straw bedding and access to free range. Based on our results, we can state statistically significant differences with value $P \leq 0.001$ in the case of indicators electrical conductivity measured after 45 minutes [mS/cm^{-1}] and also electrical conductivity measured after 24 hours [mS/cm^{-1}], shear force [$kg.\ cm^{-1}$], total water [%], total protein [%], intramuscular fat[%] , saturated fatty acid [$g.100g^{-1}$ FAME], monounsaturated fatty acids [$g.100g^{-1}$ FAME], polyunsaturated fatty acids [$g.100g^{-1}$ FAME] and omega 6 fatty acids [$g.100g^{-1}$ FAME] in *musculus longissimus thoracis.* We observed statistically significant differences with value $P \leq 0.01$ in indicators CIE L*[$g.100g^{-1}$] and CIE a* [$g.100g^{-1}$] in *musculus longissimus thoracis*. We did not detected any statistically significant differences between the groups in other indicators of pork quality.

Key Words: Pork quality, traditional farming system, conventional farming system, cultural breeds, mangalitza breed, Large White breed

The experiment was aimed at assessing of differences in the technological quality of pork from traditional farming system and modern farming system. The aim of our experiment was to determine and analyze parameters of physical and technological quality and chemical composition of pork meat in indigenous breed reared in traditional farming system in comparison with cultural breed reared in conventional farming method. SIRTORI et al. (2011) examined the effect of external and internal housing system on meat quality of pigs in their experiment. Although it was recorded that there is an influence of farming system on the quality indicators of pork (pH, CIE a *), the results were not statistically significant. The effect of welfare and housing system on behaviour, growth performance and meat quality were investigated in experiment by MORRISON et al. (2007). The authors reported statistically significant differences in the pH parameter whereby other indicators of quality were not affected the way of housing and farming condition.LEBRET et al. (2006) investigated the effect of rearing conditions on slaughter pigs before slaughter and the quality of their meat. It was found out that meat from alternative farming system had higher intramuscular fat and that rearing conditions effected meat color, CIE b *.The results from LEBRET et al. (2006) are in accordance with the results from HOLLÓ et al. (2009), BULECA et al. (2010), SUNDRUM et al. (2000), KANKA et al. (2013) who reported higher levels of intramuscular fat in the case of mangalitza breed in comparison with conventional breeds. Alternative farming system and its influence on the composition and quality of pork was the subject of GENTRY et al. (2002) study. No significant differences in the indicators of the quality of pork were found between the experimental and control group. NISTOR et al (2012) dealt with the composition of meat of mangalitza breed with a focus on composition of intramuscular fat and ratio of fatty acids in their work. In their study they indicated 10% more unsaturated fatty acid and lower content of saturated fatty acids in comparison to modern breeds. HOFFMAN et al. (2003) also introduced similar results in their experiment. Influence of traditional farming system on the quality of pork was also proved in the experiment by GALIÁN et al. (2007). The authors observed influence on the value of shear force as well as on the fatty acid composition of intramuscular fat.

Material and Methods

Animal and sample preparations

The group of pigs reared in conventional rearing system was fattened in the testing conditions of Experimental Center for Livestock. There were 10 Large White Breed pigs used in this group. These pigs were housed in pairs, one boar and one gilt. The fattening was realized from weight 30 to 100 kilograms and during this period pigs were fed with three feed rations depending on the growth phases *ad libitum* [Tab. I]. They were fed by feed mixture OŠ3 from 30 to 45 kilograms live weight, then by feed mixture OŠ4 from 45 to 70 kilograms live weight and by OŠ5 70 to 100 kilograms live weight of pigs. The group of pigs reared in alternative farming system was fattened at the University Farm Žirany. There were 10 Mangalitza Breed pigs used in this group. They were housed in group pens in the number of 10 pieces on a solid floor with straw bedding and access to free range. The paddock had size 4 x 6 meters for every pen. It was a type of soft paddock with the possibility of comfortable

manifestations of pig behavior, for example rooting. Group of pigs reared in an alternative way of farming was fed by one feed mixture OŠ-5 from 30 to 100 kilograms during the whole fattening period *ad libitum* with addition of coarse fodder in the form of maize silage and lucerne haylage mixture in a ratio 1:1 [Tab. I]. This group of pigs was slaughter in the average weight of 104.5 kg at slaughterhouse of Experimental Center of Livestock at Department of Animal Husbandry, Slovak University of Agriculture in Nitra.

Analysis of chemical and physical indicators and chemical composition of musculus longissimus thoracis

The sample of meat for chemical and physical analysis was taken from thigh *longisimus thoracis* muscle at the last and penultimate thoracic vertebra in amount of 150 g. The sampling was conducted during dissection of the carcass 24 hours *post mortem* after the process *rigor mortis*. Parameters of actual acidity - pH log. $molc^{-1}$ were measured 45 minutes and 24 hours *post mortem* with the help of pH meter Sentron with the use of microcapillary combination electrode. Parameters of electrical conductivity were determined 45 minutes and 24 hours with the use of Qualitymeter machinery in units $ms.cm^{-1}$. We determined colour of meat in values CIE L*,a*,b*. Meat colour was determined during 24 hours *post mortem*. The indicators of chemical composition were measured by the FT IR method using the device spectrophotometer Nicolet 6700 in values $g.100g^{-1}$ of samples. Fatty acids of intramuscular fat were determined in the laboratory of Institute of Chemistry, Faculty of Natural Science, Comenius University in Bratislava with the use of gas chromatography method in units $g.100g^{-1}$ FAME. We calculated basic statistical variation characteristics and one-*way analysis of variance* using the statistical software package SPSS .

Table 1. Composition of the diet

Trait	Traditional farming system (n=10)	Modern farming system (n=10)		
	OŠ-5	OŠ-3	OŠ-4	OŠ-5
Barley %	26,0	26,5	26,0	26,0
Wheat %	26,0	26,0	24,4	26,0
Corn %	27,0	17,7	26,3	27,0
Soybean meal %	15,2	26,5	20,0	15,2
Wheat bran %	3,0	0,0	0,0	3,0
Mineral and protein supplement %	2,8	3,0	3,0	2,8
Fodder acid %	0,0	0,3	0,3	0,0
Dry mater, %	90,81	90,74	90,17	90,81
N-substances, %	11,46	15,28	11,65	11,46
Metabolisable energy, MJ	13,06	13,55	13,38	13,06
Lysine, g	6,30	9,48	7,41	6,30

Results and Discussion

Based on our results from the experiment we can state that farming system had effect on indicators physical quality [Tab. IV] and chemical composition of pork. The parameter pH_1[log.molc (H^+)] was 6,148±1,757 in group from traditional farming system in comparison with modern farming system of pigs where pH_1 was 6,170±1,532. The parameter pH_{24} [log.molc (H^+)] was 5,642±1,117 in the group of pigs from modern farming system in comparison with traditional farming system of pigs where pH_{24} was 5,686±1,241. Differences between groups in the indicators of the actual acidity were not statistically significant. However, results of our experiment are not in accordance with Sirtori et al. (2011) and Morrison et al. (2007). In the electrical conductivity parameter [mS/cm^{-1}] that was measured after 45 minutes we found out value 19,469±3,080 in the group from traditional farming system and in the group from modern farming system value 6,175±30,919. In the electrical conductivity parameter [mS/cm^{-1}] that was measured after 24 hours we measured value 9,125±34,976 in the group from traditional farming system and in the group from modern farming system value 12,710±13,158. In the indicators of electrical conductivity, we observed statistically significant differences at the level of $P \leq 0{,}001$. Rearing method of pigs was also reflected in indicators of meat color. Statistically significant differences in the level of $P \leq 0.01$ was recorded in the indicator CIE L * measured after 24 hours [$g.100g^{-1}$]. We measured value 58,285±3,847 in the group of traditional farming system in comparison with modern farming system 61,808±6,163. Our results are not in accordance with the study by Morrison et al. (2007) where influence of farming metod on indicators of meat color was not confirmed. In the indicator CIE b* [$g.100g^{-1}$] we measured higher values in the group of alternative farming system 10,017±84,045 than in group of modern farming system where we found out value 8,535±74,945. However, results were not statistically significant. Our results are in agreement with Lebret et al. (2006) who in their experiment confirmed the influence of farming methods on the CIE b *. Statistically significant differences at the level of $P \leq 0{,}01$ was found also in indicator CIE a* [$g.100g^{-1}$]. Considerably higher values were measured in a group of traditional farming 5.093 ±73.590 than in the modern farming where we measured 1.584 ± 173.658. The results of our research are in accordance with Sirtori et al. (2011) who in their study found an influence on CIE a*. Highly statistically significant differences $P \leq 0.001$ were

also recorded in shear force [kg. cm^{-1}] parameter where traditional farming method showed a value 4.564 ± 22,465 in comparison with modern farming where we measured value of 3.288 ± 29.280.The influence of traditional farming method on the quality of pork was also found in the experiment Galian et al. (2007). The authors observed an influence on the value of the shear force in accordance with the results of our experiment. On the other hand in the study by Gentry et al. (2002) was not found any influence of farming method on shear force. In indicators of chemical composition of pork were also found effect of rearing system. Differences between groups were highly statistically significant at $P \leq 0.001$ in all indicators of chemical composition : intramuscular fat [%], total protein [%] and total water [%] [Tab. II]. Values of intramuscular fat [%] were higher in favor of traditional farming system 4,157±21,592 in comparison to modern farming 1,618±30,045. Total proteins [%] showed higher values 24,328±2,347 in the group of modern farming system in comparison with traditional farming system where we measured value 21,848±1,605. Total water [%] was statistically significant higher in the group of modern farming system 72,286±0,931 in comparison with total water of pork farmed in traditional way where we measured value 71,007±1,349. Highly statistically significant differences were also found in the basic composition of the fatty acids in intramuscular fat [Tab. III]. The results of our experiment also confirmed Holló et al. (2009), Buleca (2010), Sundrum et al. (2000), Kanka et al. (2013) studies. They also measured higher values of intramuscular fat in the case mangalitza breed in comparison with conventional breeds. The value of saturated fatty acids [$g.100g^{-1}$ FAME] in modern farming system was 39.130 ± 3.891 in comparison with the traditional farming system where we measured 36.262 ± 3.284 . The value of polyunsaturated fatty acids [$g.100g^{-1}$ FAME] was higher: 10.731 ± 17,146 in traditional farming system in comparison with the values in the modern farming system 7,640 ± 20,950 . In the case of monounsaturated fatty acids [$g.100g^{-1}$ FAME] , we found a higher value in favor of the traditional farming method 53.499 ± 2.367 . In the group of modern farming system, we measured value of 51.814 ± 4.185 . Statistically significant differences between groups in the case of SAFA , MUFA and PUFA were at a level of $P \leq 0,001$. Although the statistical evidence supporting differences in parameter omega 3 fatty acids [$g.100g^{-1}$ FAME] was not confirmed in a group from traditional farming system we measured value 0.475 ± 9.477 in comparison with modern farming system where we measured 0.462 ±13,044. Highly statistically significant differences we found in omega 6 fatty acids [$g.100g^{-1}$ FAME] where in modern farming system we measured value 27.666 ± 6.444 which is significantly lower in comparison with traditional farming system 9.944 ± 17,601. Nistor et al (2012 examined composition of meat mangalitza breed with a focus on composition of fat and fatty acids ratio in their experiment. In their study, they mention that there were 10% more unsaturated fatty acids and lower content of saturated fatty acids in comparison to modern breeds. Similar results were also recorded by Hoffman et al.(2003) and Galian et al. (2007) .

Table 2. Chemical composition of musculus longissimus thoracis (n=20)

Trait	Traditional farming system (n=10) mean±sd	Modern farming system (n=10) mean±sd
Total water, %	71,007±0,673^{A}	72,286±0,958^{B}
Total protein, %	21,848±0,571^{A}	24,328±0,351^{B}
Intramuscular fat, %	4,157±0,486^{A}	1,618±0,898^{B}

^{A} Different letters denote significant differences between groups at $P \leq 0.01$
^{B} Different letters denote significant differences between groups at $P \leq 0.01$

Table 3. Fatty acids in intramuscular fat of musculus longissimus thoracis ($g.100g^{-1}$ FAME) (n=20)

Trait	Traditional farming system (n=10) mean±sd	Modern farming system (n=10) mean±sd
Monounsaturated fatty acids	53,499±2,169^{A}	51,814±1,266^{B}
Polyunsaturated fatty acids	10,731±1,601^{A}	7,64±1,84^{B}
Saturated faty acids	36,262±1,522^{A}	39,13±1,191^{B}
ω3 polyunsaturated fatty acids	0,475±0,06	0,462±0,045
ω6 polyunsaturated fatty acids	9,944±1,75^{A}	6,444±1,783^{B}

^{A} Different letters denote significant differences between groups at $P \leq 0.01$
^{B} Different letters denote significant differences between groups at $P \leq 0.01$

Table IV. Pork quality of *musculus longissimus thoracis* (n=20)

Trait	Traditional farming system (n=10) mean±sd	Modern farming system (n=10) mean±sd
pH_1 - log molc. (H^+)	6,148± 0,108	6,170 ±0,095
pH_{24} - log molc. (H^+)	5,686±0,063	5,642±0,071
Electrical conductivity (45 min) - mS/cm^{-1}	3,08±1,909[A]	6,175±0,6[B]
Electrical conductivity (24 hours) - mS/cm^{-1}	9,125±1,672[A]	12,71±3,192[B]
Colour (24 hours) CIE L*	58,285±2,242[A]	61,808±3,809[B]
CIE a*	5,093±2,751[A]	1,584±3,748[B]
CIE b*	10,017±6,397	8,535±8,418
Shear force, (W-B) - kg. cm^{-1}	4,564±1,025[A]	3,288±0,963[B]

[A] Different letters denote significant differences between groups at $P \leq 0.01$
[B] Different letters denote significant differences between groups at $P \leq 0.01$

Conclusion

In conclusion, we can state that farming method influenced not only parameters of physico-technological quality but also chemical composition of pork. We found out very highly significant differences at $P \leq 0.001$ not only in indicators electrical conductivity, shear force and colour of pork but also in total water, total protein and intramuscular fat. In the case of fatty acids we found out a better ratio of saturated to mono and polyunsaturated fatty acids in meat of pigs from traditional farming system. Whereas the pork from traditional farming system has much higher content of fat and more favourable fatty acid composition of the greater importance. Differences between the groups in amount of saturated, monounsaturated and polyunsaturated fatty acids were highly statistically significant at $P \leq 0.001$. From all the results obtained in this experiment and after inter-relationships between them were judged, we can opine that alternative farming system indigenous breeds is a source of high-quality pork. This pork represents not only a valuable source of protein and vitamins, but also fat with a favourable composition of fatty acids for the consumer. In the rearing of pigs the breeds that are not so sensitive to rearing system and are more suitable for alternative farming system with straw bedding and free range should be more preferred. Alternative farming system represents not only welfare for animals but also source of pork with high quality and nutritional value.

References

BULECA, J., HÚSKA, M., REICHEL, P., TUČKOVÁ, M., MARDZINOVÁ, S. 2010. Characteristics of energetic metabolism parameters in Mangalica pig breed. In *Stocarstvo*, 2010, vol. 64, no. 2 - 4. p. 107-111.

GALIÁN, M., POTO, A., SANTAELLA, M., PEINADO, B. 2008. Effects of the rearing system on the quality traits of the carcass, meat and fat of the Chato Murciano pig. In *Animal science journal*, 2008, vol. 79, no. 4, p. 487–497.

GENTRY, J.G, MCGLONE, J.J, BLANTON, J.R, MILLER, M.F. 2002. Alternative housing systems for pigs: influence on growth, composition and pork quality. In *Journal of Animal Science*, 2002, vol. 80, no. 7, p. 1781–1790.

HOFFMAN, L.C., STYGER, E., MULLER, M. BRAND, T.S. 2003. The growth and carcass and meat characteristics of pigs raised in a free-range or conventional housing system. In *South African Journal of Animal Science*, 2003, vol. 33, no. 3 , p. 166-175.

HOLLÓ, G., SEREGI, J., ENDER, K., NÜRNBERG, K., WEGNER, J., SEENGER, J., HOLLÓ, I., REPA, I. 2003. Examination of meat quality and fatty acid composition of Mangalitsa. In *Acta Agraria Kaposvariensis*, 2003, vol. 7, no. 2, p. 19-32.

KANKA, T., ROLINEC, M., ŠŤASTNÁ, D., IMRICH, I., BÍRO, D., GÁLIK, B. 2013. Structural changes of mucous membrane and the presence of immunoglobulins in small intestines of neonatal pigs. In *Acta Veterinaria Brno, 2013, vol. 82, no. 3, p.* 317–322

LEBRET, B., MEUNIER-SALAÜN, M.C, FOURY, A., MORMÈDE, P., DRANSFIELD, E., DOURMAD , J.Y. 2006. Influence of rearing conditions on performance, behavioural, and physiological responses of pigs to preslaughter handling, carcass traits, and meat quality. In *Journal of Animal Science*, 2006, vol. 84, no. 9, p. 2436–2447.

MORRISON, R.S., JOHNSTON, L.J., HILBRANDS, A.M. 2007. The behaviour, welfare, growth performance and meat quality of pigs housed in a deep-litter, large group housing system compared to a conventional confinement system. In *Applied Animal Behaviour Science*, 2007, vol. 103, no. 1, p.12-24.

NISTOR, E., BAMPIDIS, V., PENTEA, M., PRUNDEANU, H., CIOLAC, V. 2012. Morphological Indices in Mangalitsa Breed. In *Animal Science and Biotechnologies*, 2012, vol. 45, no. 2, p. 390.

SIRTORI, F., CROVETTI, A., MEO ZILIO, D., PUGLIESE, C., ACCIAIOLI, A., CAMPODONI, G., BOZZI, R., FRANCI, O. 2011. Effect of sire breed and rearing system on growth, carcass composition and meat traits of Cinta Senese crossbred pigs. In *Italian Journal of Animal Science*, vol. 10, no. 4, p. 188–194.

SUNDRUM, A., BÜTFERING, L., HENNING, M., HOPPENBROCK, K.H. 2000. Effects of on-farm diets for organic pig production on performance and carcass quality. In *Journal of Animal Science*, 2000, vol. 78, no. 5, p. 1199-1205.

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