EFFECT OF CROSSING MANGALITSA BREED WITH LARGE WHITE TO CHEMICAL PARAMETERS AND FATTY ACID COMPOSITION IN *MUSCULUS LONGISSIMUS DORSI*

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Abstract

The aim of study was to verify the utilization of Mangalitsa breed in crossing with pig meat breed Large White in relation to chemical composition and fatty acid content of *Musculus Longissimus Dorsi* (MLD). Fifty-two pigs were used and they were divided into two groups with different genotype: Mangalitsa breed (n=16) and their crossbreeds Slovak Large White x Mangalitsa (n=36). Mangalitsa pigs were reared under intensive conditions, where the pens were situated outside. Crossbreeds Slovak Large White x Mangalitsa (SLW x Ma) were reared under inside intensive conditions. Pigs received complete feed mixture and drinking water by *ad libitum* system. The fattening period lasted from 30 kg to 100 kg. The chemical parameters such as percentage of water, protein, intramuscular fat and cholesterol content as well as fatty acid composition of MLD were measured by FT IR (FourierTransform InfraRed) method. Crossbreeds SLW x Ma had significantly higher percentage of water ($P < 0.01$) in MLD and lower percentage of protein ($P < 0.05$) compared to Mangalitsa. The intramuscular fat content as well as cholesterol content were notable lower in MLD from crossbreeds SLW x Ma than in Mangalitsa. From this results follow, that cholesterol content in meat depend on intramuscular fat content. Although the C12:0, C14:0 and C18:1*trans*-1 were lower in IMF of MLD from Mangalitsa, the IMF was more saturated as well as monounsatured and less polyunsaturated compared to crossbreeds SLW x Ma, which is showed by higher percentages of C16:0, C18:0, C18:1*cis*-9 and lower percentage of C18:2*n*-6. The C12:0, C18:1*cis*-9 and C18:3*n*-3 were significantly affected by genotype ($P < 0.001$). It can be concluded that crossbreeds SLW x Ma have comparable qualitative parameters of meat with Mangalitsa breed for production special meat products. Consequently Mangalitsa breed can improve some technological parameters in MLD by crossing with pig meat breed.

Key Words: Crossbreeds, intramuscular fat, fatty acid, Mangalitsa, meat

In recent year, the meat quality has become an important factor affecting how to pork can be used. The meat quality traits of pork depend mainly on the breed (Ruusunen et al., 2012), genotype, feeding, pre-slaughter handling and stunning, slaughter method, chilling as well as storage conditions (Andersen et al., 2005). A few years ago, the main objective of the swine industry has been to increase the lean to fat ratio of pig carcasses. As a result, dramatic improvements in the body composition of pigs have been made through genetic selection, however the quality of meat has got worst (Alonso et al., 2009). Also the role of marbling fat is of interest in pigs because genetic selection for lean pigs has been able to reduce its level to below 1 % (e. g. Large White) compared with 2-4 % in the 1960s (Alonso et al., 2010). Intramuscular fat content and fatty acid composition are important factors that conduced to eating quality. As regard intramuscular fat content in meat, IMF content positively correlates with the sensory quality of cooked meat. As IMF content increase from 1 % to 3 %, sensory quality increases at the highest rate (Jeong et al., 2010).

For many years, fatty acid composition in meat producing animals has got considerable interest in view of its implications for human health as well as for meat quality (De Smet et al., 2004). Pigs with higher body fat content tend to have a higher percentage of saturated fatty acids and lower percentage of unsaturated fatty acids (Bertol et al., 2013). However, it has been determined that increasing the polyunsaturated fatty acid (PUFA) content of meat can have harmful impact on pork quality since PUFA is particularly susceptible to oxidation, what leading to decline in quality of meat and meat products (Mas et al., 2011; Alonso et al., 2012).

Mangalitsa is characterized by robust constitution, slower growth rate with higher adiposity and reduced lean deposition compared to pig meat breeds (Vranić et al., 2015). Although it is one of the fattest pig breeds in the world, where generally has 65-75 % of fat and only 30-35 % of lean meat in the carcass (Egerzegi et al., 2003), the meat and meat products are highly accepted by consumers due to high quality of meat (Parunović et al., 2013). The meat has dark colour, high percentage of intramuscular fat and the high percentage of unsaturated fatty acids (Stanišić et al., 2015; Vranić et al., 2015).

It is needed for research on new genetic lines that can be found in the market of pork, where the crossbreeding can be used to the improvement of fattening and production parameters without decreasing eating quality of pork. For this reason, the aim of study was to verify the utilization of Mangalitsa breed in crossing with pig meat breed Large White in relation to chemical composition and fatty acid content of *Musculus Longissimus Dorsi.*

Material and Methods

The experiment was realized in the Experimental centre of department of Animal Husbandry at the Slovak University of Agriculture in Nitra. Fifty-two pigs were used, which they were divided into two groups with different genotype: Mangalitsa breed (n=16) and their crossbreed Slovak Large White x Mangalitsa (n=36). Mangalitsa pigs were reared under intensive conditions, where the pens were situated outside. Crossbreeds Slovak Large White x Mangalitsa (SLW x Ma) were reared under inside intensive conditions. Pigs received complete feed mixture and drinking water by *ad libitum* system.

The composition of diets and nutrient content are presented in Table 1 and Table 2. The complete feed mixture for crossbreeds SLW x Ma was applied at the different growth phases: OŠ-03 until 35 kg of body weight, OŠ-04 from 35 kg to 65 kg of body weight and finally OŠ-05 above 65 kg of body weight.

Table 1. *Composition of diet and nutrient content for Mangalitsa*

Traits	
Corn (%)	50
Barley (%)	10
Wheat (%)	10
Soybean meal (%)	10
Sunflower seed (%)	10
Granuled alfalfa (%)	7
[1]Mineral and vitamin supplement (%)	3
Nutrient composition	
Crude protein (g)	134
Metabolisable energy, MJ	12.6
Fibre (g)	43
Lysine (g)	9.7
SFA	11.98
MUFA	32.95
PUFA	53.46
C16:0	8.3
C18:0	2.6
C18:1n-6	32.6
C18:2n-6	52.7
C18:3n-3	0.8

[1]retinol 200 000 m.j., cholecalciferol 30 000 m.j., α-tocopherol 400 mg, riboflavin, 80 mg, pyridoxine 30 mg, cyanocobalamin 1000 mcg, niacinamide 300 mg, folic acid 2 mg, pantothenic acid 300 mg, cholinchlorid 4000 mg, Cu 600 mg, Fe 3400 mg, Zn 1000 mg, Mn 1000 mg, I 30 mg, Se 8 mg.

Table 2. *Composition of diet and nutrient content for crossbreeds*

Traits	**OS-03**	**OS-04**	**OS-05**
Wheat (%)	44	42	49
Barley (%)	22	25	28
Corn (%)	10	10	7
Soybean meal (%)	13	12	7
Wheat bran (%)	7	8	6
[1]Mineral and vitamin supplement (%)	3	3	3
Nutrient composition			
Crude protein (g)	160	150	120
Metabolisable energy, MJ	12.6	12.7	12.6
Fibre (g)	43	41	38
Lysine (g)	9.7	8.6	6.4
SFA	19.5	18.9	18.7
MUFA	19.1	18.8	18.6
PUFA	60.2	61.1	61.4
C16:0	17.4	16.9	17.1
C18:0	1.8	1.8	1.5
C18:1n-6	18.0	17.9	17.8
C18:2n-6	55.7	56.4	57.1
C18:3n-3	4.4	4.5	4.3

[1]retinol 210 000 m.j., cholecalciferol 40 000 m.j., α-tocopherol 1000 mg, riboflavin, 50 mg, pyridoxine 100 mg, cyanocobalamin 1000 mcg, niacinamide 300 mg, folic acid 2 mg, pantothenic acid 300 mg, cholinchlorid 4000 mg, Cu 450 mg, Fe 3400 mg, Zn 3500 mg, Mn 1300 mg, I 30 mg, Se 10 mg.

The fattening period lasted from 30 kg to 100 kg of body weight. Then pigs were slaughtered in the slaughterhouse at the Experimental centre of Department of Animal Husbandry. The slaughtering was done according to Slovak government regulation NR SR 432/2012 (about the protection of animal during the slaughter). Samples of *Musculus longissimus dorsi* (MLD) were carried out from the right-half carcasses. The dissection of carcasses was done according to standard practices of station of fattening and slaughter values in Slovakia (initially Slovak technical standard 46 61 64).

The chemical parameters such as percentage of water, protein, intramuscular fat and cholesterol content as well as fatty acid composition of MLD were measured by FT IR method (FourierTransform InfraRed) using device Nicolet 6700. FT IR is method of infrared spectroscopy. It is measured the amount of absorbed infrared in the homogenized sample and it is created the molecular fingerprint by interferogram.

The effect of genotype on studied parameters were analysed by the analysis of variance (ANOVA) using the Statistic Analysis System (SAS) package (SAS 9.2 using of application Enterprise Guide 5.1. (2012)). Means and standard deviation are presented in tables. The means of parameters were compared between genotypes using Tukey's test.

Results and Discussion

The basic chemical parameters of *Musculus longissimus dorsi* (MLD) are presented in Table 3. Percentage of water was significantly higher in meat from Mangalitsa compared to crossbreeds SLW x Ma ($P < 0.01$). The water content of MLD in the study of Parunović et al. (2013) were lower in Mangalitsa breed (from 62.7 % to 64.3 %) except to pig meat breed Swedish Landrace compared to our results. However the percentage of water in MLD from Mangalitsa breed was lower than in Swedish

Landrace. Similar results were achieved in the study of Tomović et al. (2016). The MLD from crossbreeds SLW x Ma had significantly higher percentage of protein than MLD from Mangalitsa ($P < 0.05$). It is in accordance with study of Sirtori et al. (2011).

The percentage of intramuscular fat was higher in MLD from Mangalitsa compared to crossbreeds SLW x Ma. Although the differences were not statistically significant, this results are consistent with cholesterol content in MLD. From this results obtained it follow that cholesterol content in meat depend on intramuscular fat content. It is in accordance with study of Alfaia et al. (2007), Petrović et al. (2010). As regards the percentage of intramuscular fat in MLD from indigenous breeds in other countries, Sirtori et al. (2011) also found that crossbreeds Large White x Cinta Senese had lower values of intramuscular fat in MLD than Italian indigenous breed Cinta Senese. Although the values were higher compared with our results. On the contrary, Poto et al. (2007) detected, that crossbreeds Chato Murciano x Large White had the highest percentage of IMF in MLD (11.17 %) compared to Spanish indigenous breed Chato Murciano and crossbreeds Chato Murciano x Iberian pig (10.47 %, 8.97 %). The intramuscular fat content in MLD is more higher compared to our results, what is probably due to rearing outdoor conditions.

Fatty acid profile of IMF in MLD between genotypes is shown in Table 4. Although the C12:0, C14:0 and C18:1*trans*-1 were lower in IMF of MLD from Mangalitsa, the IMF was more saturated as well as monounsatured and less polyunsaturated compared to crossbreeds SLW x Ma, which showed higher percentage of C16:0, C18:0, C18:1*cis*-9 and lower percentage of C18:2*n*-6. The C12:0, C18:1*cis*-9 and C18:3*n*-3 were significantly affected by genotype ($P < 0.001$). In other fatty acids were not determined statistical significance. According to De Smet et al. (2004) the content of SFA and MUFA increases faster with increasing fatness than does the content of PUFA, which lead to a decrease in the relative proportion of PUFA. Due to this fact Mangalitsa breed had in MLD higher content of SFA and MUFA with lower content of PUFA than their crossbreeds SLW x Ma. Our results are consistent with study of Renaudeau and Mourot (2007).

According to Woody et al. (2008) the target of PUFA/SFA ratio should be 0.4 or above. In our study was found ratio PUFA/SFA less (0.35 in both genotypes). The differences between genotypes were not statistical significance. It is in accordance with results of Petrović et al. (2014).

Regarding PUFA *n*-6/*n*-3 ratio, Woody et al. (2003) reported that the recommendation is for a *n*-6/*n*-3 ratio of less than 4, but pork has higher than this. In our results was found higher *n*-6:*n*-3 ratio from 18.28 to 19.29. Although the differences were not statistical significant between genotypes, crossbreeds SLW x Ma had higher *n*-6/*n*-3 ratio in IMF due to the higher content of C18:2*n*-6 in their diet and meat compared to Mangalitsa. Similar results were achieved in the study of Renaudeau and Mourot (2007).

Table 3. *Chemical parameters of Musculus longissimus dorsi*

Parameters	**Mangalitsa** (n=16)		**Crossbreeds SLW x Ma** (n=36)		**P < value**
	Mean	SD	Mean	SD	
Water content (%)	73.53	0.608	72.88	0.692	0.002
Intramuscular fat content (%)	1.93	0.911	1.66	0.551	0.190
Protein content (%)	24.15	0.656	24.54	0.425	0.015
Cholesterol content (mg.100g^{-1})	43.12	7.165	40.72	9.474	0.395

Table 4. *Fatty acid profile of Musculus longissimus dorsi*

Table 4. Fatty acid profile of *Musculus longissimus dorsi*

Parameters	**Mangalitsa (n=16)**		**Crossbreeds SLW x Ma (n=36)**		**P < value**
	Mean	SD	Mean	SD	
C12:0 (Lauric)	0.066	0.007	0.075	0.004	< 0.001
C14:0 (Myristic)	1.277	0.031	1.291	0.031	0.139
C16:0 (Palmitic)	24.40	0.184	24.34	0.226	0.351
C18:0 (Stearic)	11.08	0.203	11.01	0.208	0.239
C18:1cis-9 (Oleic)	42.03	2.047	40.61	1.444	< 0.001
C18:1trans-11 (Vaccenic)	4.57	0.115	4.62	0.082	0.067
C18:2n-6 (Linoleic)	8.51	1.242	8.55	0.561	0.896
CLA (Conjugated linoleic acid)	0.13	0.011	0.13	0.012	0.512
C18:3n-3 (α linolenic)	0.27	0.029	0.24	0.019	< 0.001
C20:5n-3 (EPA)	0.09	0.012	0.09	0.013	0.849
C22:5n-3 (DPA)	0.14	0.007	0.14	0.007	0.868
C22:6n-3 (DHA)	0.04	0.004	0.04	0.003	0.106
Total SFA	36.34	1.007	36.23	0.924	0.718
Total MUFA	50.69	1.697	50.40	1.293	0.506
Total PUFA	12.63	0.883	12.67	0.696	0.864
Total *n*-3PUFA	0.61	0.047	0.59	0.048	0.455
Total *n*-6 PUFA	11.06	0.903	11.44	0.649	0.085
Ratio *n*-6/*n*-3	18.28	1.996	19.29	1.925	0.091
Ratio PUFA/SFA	0.35	0.028	0.35	0.021	0.858

Conclusion

From the results follow, that crossbreeds SLW x Ma had significantly lower water content and higher protein content in MLD compared to Mangalitsa. Concurrently it was found, that crossbreeds SLW x Ma had notable lower content of intramuscular fat, cholesterol and higher percentage of PUFA than Mangalitsa. It can be concluded that crossbreeds SLW x Ma have comparable qualitative parameters of meat with Mangalitsa breed for production special meat products. Consequently Mangalitsa breed can improve some technological parameters in MLD by crossing with pig meat breed.

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