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THE EFFECT OF SLAUGHTER WEIGTH AND GENOTYPE ON THE FATTY ACID COMPOSITION OF INTRAMUSCULAR AND SUBCUTANEOUS FAT IN PIGS

THESES OF PH.D. DISSERTATION

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1. Introduction, the precedence of the study

1.1. Importance of slaughter performance and meat quality

The main aim of the Hungarian Animal Breeding Act is to improve the quality of animal products, the profitability of the production and increase its chances on the market by high level of breeding practice. According to the Hungarian Pig Production Test Codex, to achieve this the uniform, detailed and professional regulation of the production control and breeding value prediction as a base of selection is necessary (SERTÉS TELJESÍTMÉNYVIZSGÁLATI KÓDEX 7., 2009).

Data collected according to the standards give the possibility of describing breeds by the exact values of certain production traits, and compare genotypes based on that. However the production test method described in the Codex was developed to evaluate the meat type pig breeds belonging to breed groups I-IV.

Meat production is a polygenic trait, widely influenced by environmental factors. The quantity and value of meat production of a certain animal is defined both by the fattening and slaughtering results (DOHY, 1976). Therefore for getting comparable results about a traditional breed, we have to place it into a standardised environment unfamiliar to the breed, cause meaning an intensive housing and feeding system. Anyway, analyzing the effect of genotype on the components of slaughter performance can be done only using the same housing and feeding conditions in all genotypes compared.

There're no data indicated so far in the literature about the slaughter performance values of Swallow-bellied Mangalitsa breed in a standard production control system.

Theory about the fatty acid component of the food having a high influence on the human health is getting widespread from the point of view of healthy nutrition. The results of such researches, the professional guidelines according it are even written on the boxes of food in the stores, advertising how healthy a given product is.

The fat content of a certain meat or meat product is essential from the human consumption's point of view. Furthermore, the ratio of saturated, mono- and polyunsaturated, and ω-6: ω-3 (n-6: n-3) fatty acids is also highly important.

The fatty acid composition of fat tissues in pigs is directly influenced by the fat composition of their feed (BEE at al, 2002; KOUBA at al, 2003; NGUYEN at al, 2003), and certain genetic factors are having a high influence on it as well (MONZIOLS at al, 2007; WOOD at al, 2004a). The protein content of the meat is high in modern pig breeds and hybrids due to selection, at the same time the fat content is decreased, the ratio of polyunsaturated fatty acids being increased (EDWARDS at al, 2003).

SZABÓ and FARKAS (2002) were fattening ten breeds and crosses with different genotypes (Hungarian Large White, Hungarian Landrace, Duroc, Pietrain, Cornwall, Blonde Mangalitsa, Red Mangalitsa, Duroc x Mangalitsa F_1, Duroc x Mangalitsa F_2, Duroc x Cornwall) under the same housing and feeding conditions. They've found significant differences between the genotypes studied in the ratio of saturated and unsaturated fatty acids. CSAPÓ at al. (2002) compared the fatty acid composition and cholesterol content of samples taken from the backfat of different genotypes. Authors haven't found difference neither in saturated, unsaturated and essential fatty acid content, nor in cholesterol content in the three genotypes (Mangalitsa, Hungarian Large White x Hungarian Landrace F_1, Mangalitsa x Duroc F_1) analyzed.

The results of recent studies are controversial according to the effect of genotype on the fatty acid content. I'd like to provide further data in this field by my research, investigating the effect of genotype in four different research layouts, described in the following part, Aims of this paper.

1.2. Aims

1.) Effect of genotype on fattening and slaughtering parameters

Aim of my research was to collect information about the fattening and slaughtering performance of pigs belonging to different genotypes, fattened under same housing and feeding circumstances. I've compared the Swallow-bellied Mangalitsa to modern pig breeds in this part of the experiment.

2.) Effect of genotype on the fatty acid composition of the pork chop

Additionally, I've studied whether there's a difference in the fatty acid composition of the chop in pigs belonging to different genotypes, but fattened under the same housing and feeding conditions. I've compared the Swallow-bellied Mangalitsa to modern pig breeds.

3.) Effect of weight at slaughter on the fatty acid composition of pork chop and bacon

I was looking for answer whether there's a difference in fatty acid composition of chop and bacon in pigs fattened under the same housing and feeding conditions but slaughtered at different live weight. The pigs belonging to Swallow-bellied Mangalitsa breed were fattened till reaching live weight 105, and 140 kg in this experiment.

4.) Effect of genotype on the cutting force of chop

At last I've studied the differences in the cutting force of chop in pigs kept under the same housing and feeding conditions. I've compared the Swallow-bellied Mangalitsa to modern pig breeds in this part of the experiment.

2. MATHERIALS AND METHODS

2.1. Materials

Examinations have been carried out on the Atkár Performance Examination Station of the Central Agricultural Office. Results of the Growth Rate and Slaughter Performance Tests were used for the research. Although Swallow - bellied Mangalitsa breed is not included in the above-mentioned Test, in order to accurately compare genotypes, keeping and feeding conditions and examinations required by the Test were applied.

2.1.1. Effect of genotype on the growing characteristics and slaughter performance

Measurements at the slaughtering of 105 animals have been carried out to examine the effect of genotype on growth rate and carcass value. Individuals belonged to 7 breeds: Hungarian Large White (MNF) n=18, Hungarian Landrace (ML) n= 20, Duroc (D) n=14, Dalland (Da) n=15, Pietrain (Pi) n=12, Pietrain x Hampshire (Pi x Ha) F_1 n=18, Swallow-bellied Mangalitsa (Mangf) n=8.

3.1.2. Effect of genotype on the fat composition of the chop and bacon

Samples were taken from 59 individuals for the fatty acid analysis for investigating the effect of genotype on the fatty acid composition of the chop and bacon. These animals belonged to 6 breeds or genotypes: Hungarian Large White (MNF) n=11; Hungarian Landrace (ML) n=10; Duroc (D) n=8; Pannon Hybrid (Pan) n=10; Hungahib 39 (Hung39) n=10; Swallow-bellied Mangalitsa (Mangf) n=8.

2.1.3. Effect of slaughter weight on the fatty acid composition of the chop and bacon

Determining the effect of slaughter weight on the fatty acid composition of chop and bacon I've taken chop and bacon samples from 19 Swallow-bellied Mangalitsa individuals for the fatty acid analysis. Individuals were slaughtered in two weight categories: (1) at 105 kg live weight, as is usual in intensive technology for modern meat-type pig breeds (n=9), and (2) at 140 kg as advised traditionally for fat-type pigs (n=10).

2.1.4. Effect of genotype on primal cut values of the chop

Enlightening the effect of genotype on the cutting force values I've measured the cutting force in the chops of 91 individuals. These animals belonged to 6 breeds or genotypes: Hungarian Large White (MNF) n=16; Dalland (Da) n=19; Pannon hybrid (Pan) n=16; Hungahib 39 (Hung39) n=14, Middle-Tisza Hybrid (KTisz) n=19; Swallow-bellied Mangalitsa (Mangf) n=7)

2.2. Methods of the study

2.2.1. Performance test

Fattening and slaughtering has been carried out following the specifications of Swine Performance Test Codex (SERTÉS TELJESÍTMÉNYVIZSGÁLATI KÓDEX BIZOTTSÁG, 2007). Piglets were transferred to the performance test station not later than 77 days old. The maximum live weight of transferred animals was 34 kg.

Experiment started at 80 days of age and lasted till animal have reached 105±2 kg live weight, or in case of Swallow-bellied Mangalitsa the 140 kg weight. Individuals were measured at 80 days of age, than once a month, finally before slaughter. Feed intake was measured from the morning of the 80th day till the afternoon before slaughter.

2.2.2. Feeding

Feeding has been carried out following the specifications of Swine Performance Test Codex (SERTÉS TELJESÍTMÉNYVIZSGÁLATI KÓDEX BIZOTTSÁG, 2007). During the experiment animals were fed by granulated feed with standard composition, *ad libitum*. Feed was purchased from Agrokomlex C.S. PLC. with the required formula of the Codex.

2.2.3. Slaughter technology

Animals were slaughtered when had reached 105±2 kg body weight[1]. The process of slaughter started with stunning and exsanguinating of the animals. Pigs were de-haired by scalding technology. The hanged up and unfolded pigs were eviscerated (their digestive, respiratory, circulatory and urinary organs removed) and after that the body split by the spine of the back. The weight of the hot carcass and its weight after cooling for 24 hours were measured with 0.1 kg accuracy.

Body measures were taken on the left half-carcass. Body length and bacon thickness (at the withers, at the back and at the loin) were assigned. Carcasses were evaluated based on the EUROP standard.

Subcutaneous fat was peeled from the hot left half-carcasses. The weight of the left half-carcass (boned meat and subcutaneous fat together) and the

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[1] Only exception is the Swallow-bellied Mangalitsa population fattened to high weight.

peeled bacon with skin and subcutaneous fat were measured together and individually as well, with 0.1 kg accuracy.

The weight of the left half-carcass was measured again after 24 hours of cooling, then it was cut to pieces. During the cutting the weight of the primal cut sections – leg, chop, roast, ham - were measured with 0.01 kg accuracy.

2.2.4. Determining the cutting force values

I've determined the cutting force values at the Department of Animal Nutrition of Szent István University, Gödöllő, Hungary. During the splitting and cutting I've taken a chop sample 2.5 cm thick from every pig after the 24 hours cooling. Samples were stored chilled on -20°C in a vacuum film packing till the analysis. In case of beef there's a standardized recommendation for determining cutting force value, which is widespread. In case of pork making the method uniform is only a pursuit yet, so there're different methods for the preparation and the measuring. I've looked up in the literature and available sources the methods possible to use, and adjusted my measurements to the most current one.

Uniform conditions (12-18 h, on 4 °C) were used for slowly melting the samples. After melting I've roasted the chop slices till 72°C nuclear temperature in a contact grill oven, then cooled them to room temperature for 1.5 hours.

I've taken barrel-shaped probe bodies with 1.25 cm diameter parallel to the muscle fibres with an equipment designed for that purpose from the room temperature slices. From one slice have taken 5 probe bodies when possible, cut through each once, then the average cutting force values of the those was defined as the average cutting force value of the given slice. In case of Mangalitsa breed only three probe bodies could be obtained from one slice due to the significantly smaller chop diameter they have. Therefore in this genotype the average value of the three probe bodies gave the average cutting force value of the slice.

I've used TA.XT Plus texture analyser equipped with a Warner-Bratzler blade (60° angle, 1 mm thick, 250 mm/minute) for the measurements.

2.2.5. Fatty acid analysis

Fatty acid analysis was carried out in the Animal Physiology Department of the Research Institute for Animal Breeding and Nutrition, Hungary. Lipids were extracted following the methodology of FOLCH et al (1957).

The methyl ester derivates of the fatty acids were produced by brom-fluorid after extracting the lipids.

Gas liquid chromatography was performed on a Shimadzu 2010 apparatus (Kyoto, Japan), equipped with a capillary column (30 m × 0.25 mm i.d., 0.25 μm film, Supelco, Bellefonte, PA, USA) and flame ionization detector. To identify individual fatty acids, an authentic fatty acid standard (Mixture Me100, Larodan Fine Chemicals, AB, Sweden) was used. Individual fatty acid proportion results were given as weight% of the total fatty acid methyl esters.

2.2.6. Content analyses

I've determined the fat, protein, ash and dry material content of the chop and bacon samples during the analyses. Samples were taken following the cutting 24 hours after slaughter, and kept on -20°C till the analysis. The content analysis of the meat samples was carried out according to the following standards:

Meat moisture measurement was carried out based on the National Standard "Meat and meat products. Determination of moisture content (Reference method)" (MSZ ISO 1442). Fat content of meat was carried out based on the National Standard "Meat and meat products. Determination of total fat content" (MSZ ISO 1443)". Protein content of meat was carried out based on the National Standard "Test methods of meat products. Determination of protein content" (MSZ 5874/8-78). Ash content of meat was carried out based on the National Standard "Meat and meat products. Determination of total ash" (MSZ ISO 936).

2.2.7. Statistical evaluation

Statistical evaluation of the data has been carried out using SPSS 16.0 software. I've used variance analysis (ANOVA) for comparing the results. Tukey, or Tamhane test was used for comparing the means, based on the result of the previous homogeneity analysis. Correlation analysis was used to prove the correlation of given parameters. Statistical evaluation of the data has been carried out using SPSS 16.0 software. Diagrams were created by using Microsoft Office 2003 Excel.

3. RESULTS

3.1. Effect of genotype of fattening capacity and slaughter value

Growth rate and carcass value examinations revealed that to reach slaughter size specified by standard, Pietrain x Hampshire F_1 individuals needed the shortest period (68±5 days), while swallow bellied Mangalitsa breed required the longest period (99±10 days). Swallow bellied Mangalitsa individuals had significantly ($P<0.001$) the highest age compared to modern breeds.

Feeding up period for the total examined stock was 89 (s=±21) days. Intensive breeds reached the required weight (105±2 kg) during 2,5-3 months (84±12 days on the average of genotypes), while Mangalitsa breed needed close to 5 months (154±16 days).

Differences in feeding up period lead to different slaughter ages as Mangalitsa breed reached slaughter weight of 105 kg during 8-9 months (233±55 days), in contrast to the 5 months of modern breeds and hybrids.

During the further experiments *daily weight growth* of different genotypes was measured. Intensive swine breeds showed a growth of 810-1000 g/day (932.68±101.2 6g/day on the average of genotypes), while Mangalitsa breed only produced a half of it (482.26±71.50 g). In this trait statistically significantly Hungarian Landrace showed the best results (1025±110.7 g/day) compared to all genotypes, while Pietrain resulted in the worst (812±106.7 g/day) among modern breeds ($P<0.05$). The other modern breeds have not shown significant differences in daily weight growth. Mangalitsa breed results got the worst of all the breeds ($P<0.01$).

Considering slaughter performance, Swallow-bellied Mangalitsa and Pietrain breeds reached best results in hot carcass. These breeds did not differ from each other significantly but were superior compared to almost all genotypes studied, except Dalland hybrid ($P <0.05$).

More than double thickness of withers was measured on Swallow-bellied Mangalitsa breed compared to the average of modern type swine breeds while back and flank thickness proved to be close to four times higher.

As expected, average of *subcutaneous fat quantity* of Mangalitsa breed proved to be the highest (21.24±1.44 kg) compared to all other genotypes. Furthermore, data accounted for the least quantity of subcutaneous fat (7.88±1.76 kg) of Pietrain breed compared to the other modern genotypes.

The analysis of *subcutaneous fat rate* revealed the same order as Mangalitsa fat rate proved to be the highest (51.45±3.23 %) among examined genotypes and Pietrain accounted for the lowest rate (19.06 ±4.61%), all this confirmed by statistical analysis (P <0.05).

Statistical analysis of *primal cuts* rate revealed that Mangalitsa breed is the least successful in this parameter from all the genotypes studied, while Pietrain breed had the highest rate of primal cuts against all the other genotypes (P<0.001).

3.2. Effect of genotype on the fatty acid composition of the chop

I've evaluated the differences in chop's fatty acid composition of pigs belonging to different genotypes, kept under the same housing and feeding conditions, slaughtered at the same age.

The ratio of unsaturated fatty acids was the highest in the chop of Hungarian landrace breed, the lowest in the Hungarian Large White (P<0.05). The other genotypes investigated showed nearly equal values.

The ratio of saturated fatty acids (36.872±2.51%) in the chop of Hungarian Large White breed is lower than in Hungarian Landrace (40.44±3.14%), Duroc (41.2±1.36%) and Swallow-bellied Mangalitsa (40.94±2.76%) breeds, and in the two hybrids (Pannon 38.23±1.69%; and Hungahib 39 39.28±1.79%).

In case of *palmate acid* the highest values were measured in Swallow-bellied Mangalitsa (26.40 ±1.45%), Duroc (25.57 ±0.64%) and Hungarian landrace (25.31±1.78%). The ratio of *stearic acid* was high in the chop of Duroc (13.43±1.08%), and Hungarian landrace (13.14±1.59%) breeds, furthermore in Hungahib 39 (13.20±0.92%) hybrid. The *mystic acid* content is higher in the chop of Swallow-bellied Mangalitsa (1.49±0.12%) and Duroc (1.38±0.21%) breeds.

Comparing the means revealed, that in the chop of Swallow-bellied Mangalitsa (50.65±1.82%) the ratio of the whole mono-unsaturated fatty acids is significantly higher, than in any other genotypes studied (P<0.01). The ratio of oleic acid is relatively high in the chop and the independent value of this fatty acid in human nutritional biology is also significant. Among the genotypes studied the chop of the Mangalitsa breed was highest in oleic acid content (44.46 ±1.64%), followed by the Duroc breed (37.12 ±5.302%). The other genotypes participating in my study were almost the same in this aspect.

Analyzing the ratio of polyunsaturated fatty acids by genotypes, I could conclude that the values of Swallow-bellied Mangalitsa were significantly lower (10.25±3.53%) than any of the others studied. The individuals of Duroc breed show a low value (17.76±6.42%) as well. In all genotypes taking part in the experiment the average value of the studied population was over (19.61±6.89%). By comparing the means I could statistically proof that the ratio of polyunsaturated fatty acids in the chop of Swallow-bellied-Mangalitsa is significantly lower than the average of any other genotypes, with the exception of Duroc ($P<0.005$).

Studying the polyunsaturated fatty acids individually it can be concluded that Swallow-bellied Mangalitsa is showing tendentiously lower values compared to the other genotypes. Furthermore, the highest values can be detected in every case in Hungarian Large White.

3.3. Effect of slaughter weight on the fatty acid composition of chop and bacon

In the third experiment I've analysed the effect of different slaughter weights on the fatty acid composition of chop and bacon in the Swallow-bellied Mangalitsa breed. Individuals were fattened according to the same housing and feeding system, and slaughtered in two weight categories: in live weight 105 kg and 140 kg.

When comparing the means didn't find a statistically relevant difference in the ratio of saturated *fatty acids* of the chop and bacon between Swallow-bellied Mangalitsas slaughtered at 105 and 140 kg. In addition data showed that there's a difference in the ratio *of mono- and polyunsaturated* and *n-6/n-3 fatty acids* between the chop and bacon of Mangalitsas slaughtered at 105 kg. Bacon is having significantly ($P<0.05$) lower monounsaturated and higher polyunsaturated fatty acid ratio, and the ratio of n-6 fatty acids is higher, consequently the n-6/n-3 ratio higher as well.

I've also compared the differences between the two slaughter weights by tissue types. Analyzing the means showed that there's no statistically significant difference in the fatty acid composition of the same tissues of pigs slaughtered at 105 and at 140 kg in *saturated fatty acids* (SFA), in *monounsaturated fatty acids* (MUFA) and in *polyunsaturated fatty acids* (PUFA), or in *n-3* and *n-6 fatty acids*.

3.4. Effect of genotype on the cutting force value of the chop

During the fourth study I've analyzed the roasting loss, cutting force value and content of chop samples taken from pigs belonging to six different genotypes, fattened under same housing and feeding conditions.

According *roasting loss* the average of the chop of Swallow-bellied Mangalitsa showed the lowest value (0.14±0,02%). In an ascending order the next is the Hungarian Large White (0.15±0.02%), the Pannon hybrid (0.16±0.03%), the Dalland hybrid (0.17±0.03%), the Middle Tisza hybrid (0.17±0.03%). I've found the highest roasting loss in case of the Hungahib 39 genotype pig's chop (0.16±0.03%).

Based on the results the average cutting force value was the lowest in the chop of Swallow-bellied Mangalitsa (2.55±0.43 kg). In an ascending order the next is the Middle Tisza hybrid (2.98±0.40 kg), the Dalland hybrid (3.04±0.72 kg), the Hungahib 39 (3.12±0.84 kg), and the Pannon hybrid. The Hungarian Large White showed the highest average value in case of chop's cutting force (3.20±0.52%) Based on these data it can be concluded that the cutting force values of the modern pig bred are highly similar.

Comparing the means didn't show any statistically significant differences between genotypes, neither in roasting loss, nor in cutting force values.

4. CONCLUSIONS AND DISCUSSION

4.1. Weight gain markers

I've concluded from the results that the daily weight gain of the Swallow-bellied Mangalitsa breed is almost the third of the intensive genotypes under keeping and feeding conditions suitable for modern pork breeds. Under uniform environmental conditions needs twice as long time for reaching the 105 kg slaughter age than the modern meat breeds and hybrids. However the individual variance within Swallow-bellied Mangalitsa breed is rather high. From all that above can be concluded, that fattening Swallow-bellied Mangalitsa under intensive keeping and feeding conditions is less economical and effective than of the modern genotypes, in addition the planning of the slaughter is not secure, so the continuity of production can not be ascertained in and intensive housing and feeding system.

In case of slaughter parameters the weight of hot carcass is the highest in individuals belonging to Swallow-bellied Mangalitsa and Pietrain breeds, but in case of Swallow-bellied Mangalitsa this is due to the higher ratio of subcutaneous fat. I've concluded from that results, that Swallow-bellied Mangalitsa kept under intensive housing and feeding conditions is not fulfilling the modern consumer demand requiring higher percentage of primal cuts and lower of subcutaneous fat, although regarding other meat quality parameters (taste, water content, kitchen technique parameters) the pork of Mangalitsa may be better than the one of other genotypes.

4.2. Effect of genotype on the fatty acid composition of the chop

According the fatty acid composition of the chop the highest is the proportion of the saturated fatty acids – not advantageous from the alimentary physiology point of view – in Swallow-bellied Mangalitsa. However, the high values of monounsaturated fatty acids, including oleic acid is advantageous. The low proportion of polyunsaturated fatty acids in the chop of Swallow-bellied Mangalitsa is disadvantageous taking physiological effect of the human consumption, but can be favourable to the shelf live of the pork. Preferential the low ratio of n-6 fatty acids, nevertheless this combined with lower n-3 fatty acid proportion is unfavourable. In total Mangalitsa is having the highest n-6/n-3 fatty acid ratio among the genotypes studied which is also disadvantageous regarding the theories of healthy nutrition.

Must be stressed out, that my results according the disadvantageous fatty acid composition shows only that under intensive keeping system formed to the needs of modern pork breeds the chop of Swallow-bellied Mangalitsa has less favourable fatty acid composition according nutritional physiology than the other genotypes studied. This can awake two thoughts. On one hand, the keeping and feeding system used during performance tests is not suitable for the meat quality of the breed; on the other hand the common statement that “the pork of Mangalitsa is healthier” can’t be true. When investigating the breed’s nutritional value compared to other genotypes, kept under standardized, intensive conditions the pork of Mangalitsa cannot be defined as healthier. May be supposed, that in an extensive keeping system the meat quality of Mangalitsa is more favourable, but in this case the combined effect of the breed and the technology must be emphasized.

4.3. Effect of slaughter weight on the fatty acid composition of the chop and bacon

There’s no difference in the saturated fatty acid ratio of chop and bacon – regardless the slaughter weight – in Swallow-bellied Mangalitsas fattened under intensive keeping and feeding conditions. However the ratio of monounsaturated fatty acids is lower, the ratio of polyunsaturated fatty acids is higher in the bacon than in the chop

The ratio of n-6/n-3 fatty acids is higher in the bacon both in the pigs slaughtered at 105 and at 140 kg of live weights, but from different reasons. In individuals slaughtered at 105 kg the ratio of n-6 fatty acids is significantly higher, therefore also higher the n-6/n-3 fatty acid proportion is; at the same time in ones slaughtered at 140 kg the n-3 ratio is lower in the bacon, causing the increased n-6/n-3 proportion compared to the chop.

I’ve concluded from the results that under intensive keeping conditions and feeding adjusted to the need of modern pork breeds the slaughter weigh (105kg, and 140 kg) has no effect on the fatty acid composition of the chop and bacon. Based on that increasing the fattening weight can’t meliorate the fatty acid composition of the Swallow-bellied Mangalitsa, as fattening weight is not influencing the fatty acid composition neither of the chop, nor of the bacon.

4.4. Effect of genotype on the fatty acid composition of the chop

According to roasting loss and cutting force value no statistically significant difference could be found between the studied genotypes, so under intensive keeping and feeding conditions the expected result – Mangalitsa’s meat being crumblier, loamier – couldn’t been verified under intensive keeping and housing conditions.

Correlation analysis showed a significant strong positive correlation between the average cutting force value and roasting loss (r_{xy}=0.516, P<0.001), however there’s no statistically verifiable correlation between the average cutting force value and any of the content values measured.

As a summary it can be stated that growth rate, slaughter parameters, meat quality and fatty acid composition values of Swallow-bellied Mangalitsa breed proved to be lower, compared to modern genotypes under intensive keeping and intensive feeding system developed for modern meat-type swine breeds. This has a clear message for the practice: the keeping and feeding technology I’ve applied in my study is not suitable for the Swallow-bellied Mangalitsa. Therefore if fast and effective production of Mangalitsa pork of good quality is our aim housing and feeding conditions have to be well defined. Advantages of Mangalitsa breed meat quality cannot be realized under conditions created for modern meat-type swine breeds. Application of intensive technology developed for modern breeds for the fattening of Mangalitsa breed is unadvisable, leading the loss of advantages of the breed.

5. NEW SCIENTIFIC RESULTS

1. I've proofed, that under keeping and feeding conditions defined in the Hungarian Swine Performance Test Codex the Swallow-bellied Mangalitsa had reached the slaughter weight 105±2 kg at 154±15 days old, which is significantly higher than the results (84±12 days) of the modern pig breeds (Hungarian Large White, Hungarian Landrace, Duroc, Dalland, Pietrain, Pietrain x Hampshire). While the *average daily weight gain* of the intensive breeds were 932.68±101.26 g, the average daily weight gain of the Mangalitsa breed was 482.6±71.50.

2. I've proofed, that under intensive keeping and feeding conditions *subcutaneous fat content* (21.24±1.44 kg), and the *subcutaneous fat ratio* (51.45±3.23 %)was highest, while the *ratio of first cut* (32.47±5.58%) was lowest in Swallow-bellied Mangalitsa comparing the studied genotypes. a

3. I've proofed, that there're significant differences in the chop's fatty acid composition of pigs from different genotypes, kept according to the same housing and feeding conditions. Thus, the ratio of saturated fatty acids is the lowest in the chop of Hungarian Large White Breed (36.87±2.51%), which significantly differs ($P<0.05$) from the values measured in the chop of Hungarian Landrace (40.44±3.14%), Duroc (41.2±1.36%) and Swallow-bellied Mangalitsa (40.94±2.76%). The ratio of monounsaturated fatty acids was significantly higher ($P<0.001$) in the chop of Swallow-bellied Mangalitsa (50.65±1.82%) than in any other of the genotypes studied, due to the high *oleic acid* content. The ratio of polyunsaturated fatty acids was significantly lower ($P<0.01$) in the chop of Swallow-bellied Mangalitsa breed (10.25±3.53%) than in other examined genotypes, except the Duroc breed

4. I've proofed that fatty acid composition of different tissues of individuals of Swallow-bellied Mangalitsa breed fattened under intensive housing and feeding conditions until 105 and 140 kg slaughter weight are almost the same, so fattening weight doesn't have an effect on this studied parameter.

5. I've proofed that there's no statistically relevant difference in roasting loss and cutting force value between the studied genotypes (Hungarian large White, Dalland, Pannon hybrid, Hungahib 39, Middle Tisza hybrid, Swallow-bellied Mangalitsa).

6. ARTICLES PUBLISHED BY THE CANDIDATE

Scientific articles about the topic of the thesis

Scientific articles published in journals with impact factor

Seenger J., K. Ender, Cs. Ábrahám, E. Szűcs, G. Kuhn, K. Nürnberg (2005): Vergleichende Untersuchungen zur Bestimmung der Zartheit beim Rindfleisch. Züchtungskunde 77 (2-3) S. 281-290, 2005.

Seenger J., G. Nürnberg, M. Hartung, E. Szűcs, K. Ender and K. Nürnberg: ANKOM – a new instrument for the determination of fat in muscle and meat cuts – a comparison. Arch. Tierz., Dummerstorf 51 (2008) 5, 449-457.

Ábrahám Cs., Balogh K., Weber M., **Seenger J.,** Mézes M., Fébel H., Szűcs E., Ender K. (2005): Lairage time is a compromise. Effect of preslaughter handling on stress response and meat quality of pigs. Fleischwirtschaft International. 2. 10-12.

Scientific articles published in other supervised journals

Óváry M., Holló G., Ábrahám Cs., Csapó J., **Seenger J.,** Holló I., Szűcs E. (2003): Az íz szerepe a hús élvezeti értékében. Acta Agraria Kaposváriensis. Kaposvár, 2003. 7. köt. 1. sz. 63-74. p.

Seenger J., Ábrahám Cs., Ender K., Szűcs E. (2003): Porhanyósság-meghatározási módszerek összehasonlítása marhahúsnál. a Hús. Budapest, 13. köt. 3. sz. 141-144. p.

Holló G., Seregi J., Ender K., Nuernberg, K., Wegner, J., **Seenger J.**, Holló I., Repa I.: A mangalica sertések húsminőségének, valamint az izom és a szalonna zsírsavösszetételének vizsgálata. Acta Agraria Kaposváriensis (2003) Vol 7 No 2, 19-32 p.

Holló, G., Seregi, J., **Seenger, J.**, Repa, I. (2003): A mangalica sertés különböző szöveteinek zsírsavösszetétele az élőtömeg függvényében. A Hús, (3): 145-148

Heincinger M., **Seenger J.**, Ábrahám Cs., Radnóczi L. (2007): Genotype effect on the pala-tability of the pork loin. Bulletin of the Szent István University 15-22.p.

Heincinger Mónika, Weber Mária, Balogh Krisztián, **Seenger Julianna**, Ábrahám Csaba, Mézes Miklós (2008): Egyes hazai sertésfajták és hibridek húsminőségi paramétereinek összehasonlítása. A sertés 2008/1. 34-38.p.

Articles published in full text form in conference materials:

Seenger J., Ábrahám Cs., Szűcs E. (2003): A hús porhanyósságával kapcsolatos mérések problematikája. EU-konform Mezőgazdaság és Élelmiszerbiztonság. Szent István Egyetem Gödöllő, Mezőgazdaság- és Környezettudományi Kar, Agrártudományi Centrum Debrecen, Mezőgazdaságtudományi Kar. Nemzetközi Konferencia, Gödöllő, június 5. II. köt. 71-75. p.

Seenger J., Ábrahám Cs., Weber M., Balogh K., Mézes M., Fébel H., Szűcs E.: Zsírsavösszetétel vizsgálatok különböző genotípusú sertésekben. „Verseny élesben” Európa-napi Konferencia. Nyugat-Magyarországi Egyetem, Mezőgazdaság-és Élelmiszertudományi Kar, Mosonmagyaróvár, 2005 május 5-6.

Articles published as an abstract in conference materials:

Seenger J., Ábrahám Cs., Szűcs E. (2003): A porhanyósság mérésére szolgáló módszerek összehasonlítása, valamint a mintavételi hely nyíróerő értékre kifejtett hatása a szarvasmarha hosszú hátizomban. IX. Ifjúsági Tudományos Fórum. I. Állattenyésztés. Veszprémi Egyetem Georgikon Mezőgazdaságtudományi Kar, Keszthely, március 20. 112. p.

Seenger J., Ábrahám Cs., Holló G., Ender K., Szűcs E. (2003): Comparison of cooking and measuring methods as well as anatomical location on tenderness in M. longissimus dorsi in beef. 2003 Joint Annual Meeting of American Dairy Science Association, American Society of Animal Science and Mexican Association of Animal Production. June 22 – 26, Phoenix, Arizona, USA. Journal of Dairy Science Vol. 86. Suppl. 1., Journal of Animal Science, Vol. 81. Suppl. 1. 138. p.

Seenger J., Cs. Ábrahám, M. Mézes, H. Fébel, E. Szűcs (2005): Fatty acid composition in different tissues of Mangalitsa crossbreds. 56thAnnual Meeting of the European Association for Animal Production, Uppsala, Sweden, 5-8 June 2005. Book of Abstracts No. 11. 229 p.

Ábrahám Cs., M. Weber, K. Balogh, **J. Seenger**, M. Mézes, H. Fébel, E. Szűcs: The effect of driving pigs to stunning prior to slaughter on their stress status and meat quality. 56thAnnual Meeting of the European Association for Animal Production, Uppsala, Sweden, 5-8 June 2005. Book of Abstracts No. 11. 230 p.

Seenger J., K. Nuernberg, G. Nuernberg, M. Hartung, Cs. Ábrahám, E. Szűcs , K. Ender: Comparison of methods for the determination the fat content of Meat. 57th Annual Meeting Of The European Association For Animal Production, Antalaya, Turkey, September 17-20, 2006. N 32.20

Ábrahám Cs, J. **Seenger, M.** Weber, K. Balogh, E. Szűcs and M. Mezes: Effect of Processing Technology on Meat Quality of Pigs. 57th Annual Meeting of the EAAP, Antalya-Turkey, 2006 N32.12.

Seenger Julianna, Karin Nürnberg, Klaus Ender, Szűcs Endre: A hús zsírtartalmát meghatározó módszerek összehasonlítása. XIII. ITF, 2007. március 22., Keszthely.

Heincinger Mónika, **Seenger Julianna**, Ábrahám Csaba, Mézes Miklós (2007): A genotípus hatásának vizsgálata a sertéskaraj porhanyósságára. XIII. Ifjúsági Tudományos Fórum, 2007. március 22. Keszthely.

Julianna Seenger, Hedvig Fébel, Csaba Ábrahám, Mária Weber, Krisztián Balogh, Mária Horvainé Szabó, Mónika Heincinger, Miklós Mézes (2011): Performance test results of Swallow Bellied Mangalitsa compared to modern genotypes. Fatty Pig Science and Utilisation International Conference, 2011. november 17-19. Herceghalom. (Elfogadva 2011. 10. 31.)

Hedvig Fébel, **Julianna Seenger**, Mária Horvai Szabó, Csaba Ábrahám, Mária Weber, Krisztián Balogh, Miklós Mézes: (2011): Comparison of fatty acid profile of different type of pigs (meat and fat-tipe) fed same composition of diet. Fatty Pig Science and Utilisation International Conference, 2011. november 17-19. Herceghalom. (Elfogadva 2011. 10. 31.)

Krisztián Balogh, Mária Weber, Mónika Heincinger, **Julianna Seenger**, Miklós Mézes: Lipid peroxide and gluthation redox status of liver, spleen, and kidney in different genotypes of pigs Fatty Pig Science and Utilisation International Conference, 2011. november 17-19. Herceghalom. (Elfogadva 2011. 10. 31.)

Scientific articles about other topics than the thesis is about

Articles published in a supervised journals:

Ábrahám Cs., **Seenger J**., Szűcs E. (2003): Stresszállapot és annak mérhetősége. Állattenyésztés és Takarmányozás 52. köt. 6. sz. 527-537. p.

Szűcs E., Fébel H., Janbaz, J., Huszenyicza Gy., Mézes M., Tran A.T., Ábrahám Cs., Gáspárdy, A., Györkös I., **Seenger J.**, Nasser, J.A.(2004): A borjúkorban ACTH terhelési tesztre adott válaszreakció és a kifejlettkori tejtermelés közötti összefüggés. Állattenyésztés és Takarmányozás 53. köt. 1. sz. 5-14. p.

Szűcs, E., Fébel, H., Janbaz, J., Huszenicza, Gy., Mézes M., Tran, A. T., Ábrahám, Cs., Gáspárdy, A., Györkös, I., **Seenger, J**., Nasser, J. A. (2003): Response to ACTH Challenge in Female Dairy Calves in Relation to Their Milk Yield. Asian-Australasian Journal of Animal Sciences. Official Journal of the Asian-Australasian Association of Animal Production Societies. Kyunggi-do, Korea. 16. köt. 6. sz. 806-812. p.

Articles published in full text form in conference materials:

Ábrahám Cs., **Seenger J.,** Szűcs E. (2003): A gazdasági állatok stresszállapotának mérési lehetősége. EU-konform Mezőgazdaság és Élelmiszerbiztonság. Szent István Egyetem Gödöllő, Mezőgazdaság- és Környezettudományi Kar, Agrártudományi Centrum Debrecen, Mezőgazdaságtudományi Kar. Nemzetközi Konferencia, Gödöllő, június 5. II. köt. 66-70. p.

Szűcs E., Fébel H., Janbaz J., Huszenicza Gy., Mézes M., Tran A. T., Ábrahám Cs., Gáspárdy A., Györkös I., **Seenger J.,** Jamal A. N. (2003): A borjúkorban ACTH terhelési tesztre adott válaszreakció és a tejtermelés közötti összefüggés. EU-konform Mezőgazdaság és Élelmiszerbiztonság. Szent István Egyetem Gödöllő, Mezőgazdaság- és Környezettudományi Kar, Agrártudományi Centrum Debrecen, Mezőgazdaságtudományi Kar. Nemzetközi Konferencia, Gödöllő, június 5. II. köt. 82-85. p.

Superviesd articles published as an abstract in conference materials:

Seenger J., Ábrahám Cs., Ender K., Szűcs E. (2003): Tenderness differences due to cooking and measuring process as well as anatomical location in bovine M. Longissimus dorsi. Nordic Association of Agricultural Scientists 22nd Congress "Nordic Agriculture in Global Perspective". July 1–4 Turku, Finland. Proc. 92. p.

Ábrahám Cs., **Seenger J.,** Szűcs E. (2003): Testing stress status and performance in beef cattle. Nordic Association of Agricultural Scientists 22nd Congress "Nordic Agriculture in Global Perspective". July 1–4 Turku, Finland. Proc. 266. p.

Seenger J., Szűcs E (2005): Különböző genotípusú sertések szöveteinek zsírsavösszetétele. Proc. XI. Ifjúsági Tudományos Fórum, Keszthely. 2005. március 24. 211 p.

Ábrahám Cs., Weber M., Balogh K., **Seenger J.,** Mézes M., Fébel H., Szűcs E.: Új adatok az elektromos ösztöke kábítás előtti alkalmazásáról. „Verseny élesben" Európa-napi Konferencia. Nyugat-Magyarországi Egyetem, Mezőgazdaság-és Élelmiszertudományi Kar, Mosonmagyaróvár, 2005 május 5-6.

Ábrahám Cs., **Seenger J.,** Szűcs E. (2003): The effect of lorry on meat quality. 2003 Joint Annual Meeting of American Dairy Science Association, American Society of Animal Science and Mexican Association of Animal

Production. June 22 – 26, Phoenix, Arizona, USA. Journal of Dairy Science Vol. 86. Suppl. 1., Journal of Animal Science, Vol. 81. Suppl. 1. 137. p.

Holló G., Andrássy Z., Ábrahám Cs., **Seenger J.,** Zándoki R., Seregi J., Repa I., Holló I. (2003): Effect of breed and nutrition on carcass and beef quality traits. Proc. of the 54TH Annual Meeting of the European Association for Animal Production. Roma, Italy, 31 August- 3 Sept. 171.p.

Szűcs E., Fébel H., Mézes M., Holló G., Huszenicza Gy., **Seenger J.**, Tran A T, Ábrahám Cs., Gáspárdy A., Györkös I. (2003): An attempt at metabolic typing of juveniles using GTT in association with dairy performance. 54th Annual Meeting of EAAP. 31 August – 3 September, Rome, Italy. Commission on Animal Physiology Ph 4.10, 245. p.

Other articles:

Seenger J., Ábrahám Cs. (2002): A sertés legfontosabb viselkedésformái, s azok gyakorlati jelentősége, Agrárius-agrárinformációs magazin, 5. szám: 22-23. p.

Seenger J., Ács T., Ábrahám Cs. (2003): Az EU állattartásra vonatkozó előírásai. Agrár Unió, Agárinfomrációs szaklap. 3. szám, 16-17 p.

Seenger J., Ábrahám Cs. (2003): A HACCP alkalmazásának irányelvei. Agrár Unió, Agrárinformációs szaklap. 4. szám, 4. p.