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EFFECT OF PERIMORTAL FACTORS ON THE STRESS LEVEL AND SOME TECHNOLOGICAL MEAT QUALITY PARAMETERS OF SLAUGHTER PIGS

Ph.D. thesis

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1. SCIENTIFIC BACKGROUND

Food production is determined by the consumers' need. The joint interest of the producers and processors is to produce products, which will be bought at a good price both on the domestic and international markets. It is complicated to ensure the permanent quality of the meat products, because quality of the raw meat is influenced by several factors.

The inferior meat, especially the reduced water-holding capacity, quality causes an outstanding problem for the meat industry. According to the estimation of a previous study, the drip loss is unreasonably high in more than 50 % of the meat products (*Kauffmann et al.*, 1993). The loss can reach 10 % if the product is made from any extreme, e.g. PSE raw meat (*Melody et al.*, 2004).

The meat colour gives the base of the consumer's decision. It is determined by the concentration and chemical status of the pigments (myoglobin), and by some physical properties relating with the colloid chemical structure of the meat.

The meat quality is changing continuously due to the breeding efforts. Selection for higher carcass yield might cause decay of meat quality even in animals free of halothane gene confirmed in several former studies (*Barton-Gade*, 1996; *Oksjberg et al.*, 2000).

Genetic background, management and feeding technology and perimortal factors can have negative effect on drip loss, meat colour, as well as on tenderness and taste of the meat. Consequently, significant loss of quality might occur causing serious deficit for the processors. Although factors defining meat quality are numerous, management in the last few days/hours before slaughter and technology of processing, especially the primary processing seems to have crucial effect on meat quality.

Obviously, swine suffer from more negative impacts preliminary to slaughter, than in its whole life. Weight and capacity of heart in the intensive swine varieties are relatively small compared to their body weight, and heat control is also weak. Therefore, frequency of fatal heart and vascular abnormalities is high and animals cannot tolerate heat stress too much. During transportation from the farm to the slaughterhouse until slaughter, several negative effects occur and cause stress to the animals. The most prominent of these proven to modify meat quality are following ones: driving up and down the lorry (*Van Putten and Elshof,* 1978; *Brown et al.,* 2005; *Nanni Costa et al.,* 2002), transportation (*Barton-Gade*, 1997), leaving the relatively stress-free environment of the piggery, new staff (*Abbott et al.*, 1997), rough handling, mix-up of animals (*Guise et al.*, 1989; *Faucitano*, 2001), method of driving to the slaughterhouse (*Brown et al.*, 1998, *D'Souza et al.*, 1998), high level of noise, mis-planned lairage (*Vadáné*, 1996), deficient or damaged stunning equipment.

2. OBJECTIVES

Purpose of my research was to evaluate how different perimortal and post mortem factors influence stress of the animal and quality of its meat. My objectives were as follow:

1. To evaluate the effect of genotype and gender on meat quality, especially on pH, meat colour and water holding capacity of meat;
2. To evaluate the effect of year and month on meat quality and to study the development of meat quality in the main Hungarian breeds;
3. To evaluate the effect of transportation and lairage on meat quality in halothane negative pigs in large scale slaughtering technology;
4. To evaluate the effect of perimortal factors, like use of goad, on stress and meat quality of slaughter pig;
5. To compare the slaughtering technologies of small- and large-scale processing and to evaluate their effect on meat quality;
6. To evaluate the relationship of meat quality parameters and their practical usefulness.

3. MATERIAL AND METHOD

3.1. Effect of genotype and gender on meat quality

My study was done at the swine test station located in Atkár, controlled by the National Institute for Agricultural Quality Control. The data of Growing and Slaughtering Tests of the last five years (2000-2004) were processed. Seven breeds were involved in the evaluation: Hungarian Large White (HLW; n=5015), Hungarian Landrace (HL; n=1392), Duroc (D; n=241), Pietrain (Pi; n=241), Hungarian Large White x Hungarian Landrace (HLWxHL; n=1538) Pietrain x Hampshire (Pi x Ha; n=160) and Pietrain x Duroc (Pi x D; n=248).

In the evaluation of gender on meat quality barrows (n=7185) and sows (n=7229) were compared.

Raising and slaughtering of the animals were carried out according to the instructions of the Hungarian Pig Test Codex.

Meat quality was evaluated with pH (measured 45 min and 14 hours after stunning), meat colour, sensory judgement score, cooling loss and with identifying extreme meat quality (PSE and DFD). Measurement of the mentioned parameters and calculations were prepared according to the instructions of the Hungarian Pig Test Codex.

Results were statistically analysed with variation analysis (ANOVA), Kruskal-Wallis test and with LSD test. SPSS 14.0 software was used fro statistical evaluation.

3.2. The effect of year and month on meat quality

I studied the year and month effect on meat quality using the database of the same swine test station of the National Institute for Agricultural Quality Control, like above. Data of the last 11 years (1995-2005) were used in the study. To eliminate the effect of breed, data of the two most frequent Hungarian breeds, the Hungarian Large White (HLW) and Hungarian Landrace (HL) were used.

The raising and slaughtering of the animals, as well as measurement and evaluation of meat quality parameters were carried out according to the instructions of the Hungarian Pig Test Codex.

For statistic evaluation ANOVA analysis and Kruskal-Wallis test were used, while LSD test was also done for determining month effect. Statistic analysis was done with SPSS 14.0 and Statistica 4.5. software.

3.3. Effect of transportation and lairage on stress level and meat quality

I studied the effect of transportation and length of lairage on the stress level and meat quality of slaughter pigs. Pigs of the same genotype (n=40) were divided into two groups after the arrival at the slaughter-house: 1 vs. 16 hours of lairage. Blood samples were taken three times (before and after transportation and during bleeding), and concentrations of cortisol, non esterified fatty acids (NEFA), lactate, glucose, Vitamin C, malonyl aldehyde (MDA), reduced glutathione (GSH) and the activity of glutathione peroxidase (GSHPx) were determined. To describe meat quality the common parameters (pH_1, pH_2, T, L^*, a^*, b^*) were measured 45 minutes and 24 hours after stunning in the loin and ham. Detailed description of the biochemical analyses is presented in chapter 3.7., while methods of meat quality are summarized in chapter 3.8. Statistic analysis was done with Student's t-test with the use of SPSS 14.0 software.

3.4. Effect of electric goad on stress level and meat quality

In this experiment I studied the effect of the electric goad used during driving the animals to stunning on stress level and meat quality. Pigs transported and lairaged according to the same method were driven to the stunning (A) with (n=20) and (B) without (n=20) using an electric goad. Blood samples were taken twice: first 1 hour prior stunning and second during bleeding. The measured biochemical and meat quality parameters were the same as in chapter 3.3. Statistic analysis was done with Student's t-test using SPSS 14.0 software.

3.5. Effect of slaughtering technology on meat quality

The two used slaughtering technologies, (A) small-scale and (B) large-scale technologies were different at several parameters, like the distance between the lairage pen and the stunning device (A: 5m vs. B: 30 m), the method of driving (A: with a stick vs. B: with an electric goad) and stunning (A: manual vs. B: automatic) of animals, as well as the time required from the stunning to chilling (A: 45 minutes vs. B: 54 minutes). Blood samples were taken during bleeding and concentration of lactic acid, glucose, MDA, GSH and activity of GSHPx were measured in them. Meat quality parameters were the same as it was described earlier. Statistic analysis was done with Student's t-test with the use of SPSS 14.0 software.

3.6 Relationship between the meat quality parameters, measuring and evaluating meat quality

3.6.1. Correlation of meat quality parameters

I have revised the correlation of certain quality factors and their relevance to predict meat quality. Correlation coefficients were calculated both for own results and for records of the database of performance tests. The latter coefficients were calculated separately for HLW and HL breeds.

Besides these, correlation between lactate concentration and meat quality parameters, as well as relationship between production traits like weight gain, feed conversion ratio, factors of slaughter value and meat quality were studied.

3.6.2. Effect of loin-size on meat quality

To analyse the relation between slaughter value and meat quality, correlation of loin-size and meat quality was studied. This analysis was done with two breeds – HLW and Pi.

Loins were assigned into free weight groups: small - < 4 kg; medium – 4-5 kg; large - >5 kg.

Correlation between loin-size and meat quality parameters was calculated with ANOVA test, for which SPSS 14 software was used.

3.6.3. Effect of measuring point within the loin on meat quality

I also studied the changes of the meat quality parameters in the loin, the largest anatomically uniform muscle. Measurements were done in the left loin of 40 individuals of the same genotype. Meat colour and pH 24 hours after slaughter were measured.

Four measuring points were compared, which were the followings: (1) *lateral* point of the *cranial* end of the loin; (2) *medial* point of the *cranial* end of the loin; (3) geometrical mean point of the loin; (4) *medial* point of the *caudal* end of the loin.

Evaluation of relationship between measuring point and meat quality was done with ANOVA. Difference among the measuring points was compared with LSD test.

3.6.4. Role of sensory analysis in the estimation of meat quality

In this part of my studies, crucial decision-making factors of sensory analysis in the performance tests were analysed. Rank-correlation coefficients between sensory analysis score and the certain meat quality parameters were calculated.

3.6.5. Identification of PSE and DFD characters

Generally, PSE character is determined exclusively with value of pH_1, while DFD with pH_2. I studied the relevance of this method. For this purpose, loin of HLW swines were characterised considering PSE and DFD characters and their quality was compared with normal quality loins. I studied, whether one quality parameter (like pH) is really capable to determine meat quality of the two extreme meat characters.

3.7. Biochemical methods

3.7.1. Indicators of stress

The following parameters were measured to describe stress: blood plasma concentration of cortisol, non-esterified fatty acids (NEFA), lactate and glucose.

Cortisol level was measured with ^{125}I radioimmunoassay according to *Csernus et al.* (1982), while enzymatic colorimetric method was used for NEFA (NEFA kit, Randox, Cork), lactate (L-lactate (PAP) kit, Randox, Cork) and glucose (Diagnosticum Rt., Budapest) determination.

3.7.2. Parameters of lipid peroxidation and antioxidant defence

To characterise the level of lipid peroxidation and antioxidant status the following parameters were measured: concentration of malonyl dialdehyde (MDA), reduced glutathione (GSH) and vitamin C as well as activity of glutathione peroxidase.

Concentration of MDA, GSH and activity of GSHPx activity were measured in the blood plasma and in 1:9 erythrocyte haemolysate. Vitamin C concentration was measured in the blood plasma.

MDA concentration describing lipid peroxidation level was analysed with 2-thiobarbituric acid reaction in the blood plasma and erythrocyte haemolysate according *Placer et al.* (1966), while it was measured in native 10.000g homogenate of liver samples according to *Mihara et al.* (1980).

Concentration of GSH and activity of the GSHPx were measured to describe the antioxidant status. The former parameter was analysed according to *Sedlak et al.* (1968), end-point enzyme assay described by *Matkovics et al* (1988) was used for enzyme activity analysis. GSHPx activity was calculated for protein concentration. Protein concentration was measured with biuret reaction in blood plasma and erythrocyte haemolysate (*Weichselbaum,* 1948), while Folin phenol reagent was used in the case of liver homogenate (*Lowry et al.,* 1951).

Concentration of vitamin C was determined according to *Omaye et al.* (1979).

3.8. Methods to determine meat quality

3.8.1. pH-determination

Measurements were carried out at generally accepted periods namely 45 minutes following slaughter, and than after 24 hours of cooling period. pH was always measured in intact muscles having industrial importance, i.e. in *m. longissimus dorsi* and *m. semimembranosus*.

3.8.2. Colour analysis

Meat colour was measured after cooling, during the chopping, on fresh cross-section of the loin. Minolta CR-330 (Minolta Co., Japan) analyser was used with D65 light source and 0° angle of incidence. CIELAB system was applied to evaluate meat colour L*, a* and b* parameters.

3.8.3. Other meat quality parameters

Core temperature of muscles was measured 45 minutes after slaughter in the industrially important meat parts, namely in the loin and ham. For this purpose calibrated core thermometer was used and one measurement was carried out in each muscle.

Honikel Test was applied to measure water holding capacity as an indicator of slaughter technology. Therefore, a 2 cm thick meat slice was weighed, packed in a net and hanged up. After 24 hours of hanging slice was weighed again. Difference between the two weights referred to the original weight means the drip loss.

4. EVALUATION OF EXPERIMENTAL RESULTS

4.1. Effect of genotype and gender on meat quality

Significant effect of genotype was found in each measured and calculated meat quality parameters.

Besides a few cases, each genotypes were different, considering the value of pH_1. Pietrain breed had the lowest pH_1 value. The average of 5.90 is almost 0.1 lower, than any other breed. This genotype has even the lowest pH_2 (5.71±0.10) value, which implies the lowest meat colour Optostar value (64.17± 4.48) consequent to the correlation of the two parameters (*Tam et al.*, 1998; *Hambrecht et al.,* 2003; *Moeller et al.*, 2003; *Newcom et al.*, 2004). Meat quality of the Pi x D genotype appeared to be somewhat better, than that of the purebred Pietrain ought to the beneficial effect of Duroc breed confirmed earlier (*Langlois et al.*, 1989, *Cameron et al.*, 1990). Differences of pH were reduced until 24^{th} hours following the slaughter, therefore less statistic significance was found among the breeds.

I found similar results in the colour of meat samples taken at the same periods, so as having the same biochemical status. This confirms the strong correlation of the two parameters. Considering the results of meat colour measurements, differences among the breeds were statistically significant, however, the 2-3-point differences found are not sensible for consumers and therefore, this has no or minimal practical importance. Similar to my results minimal genotype effect on meat colour was shown in former studies, in which the colour was evaluated either with sensory analysis (*Ellis et al.*, 1996) or with objective measurement of myogloin concentration (*Nieuwhof et al.,* 1991). However, several authors reported significant advantage of Duroc breed considering meat colour. The colour of their meat was more intensive as compared to the Hungarian Large White (*Candek-Potokar et al.,* 2002), or Landrace (*Cameron et al.*, 1990) breeds.

It is also difficult to create uniform definition of genotype effect on water holding capacity, as contradictory results are available in the literature, as well. Some authors reported significant genotype effect on water holding capacity (*Martel et al.*., 1988, *Nieuwhof et al.*, 1991, *Candek-Potokar et al.*, 2002), while other did not find any genotype effect (*Latorre et al.*, 2003). Differences in cooling loss, I have found, were also small in numbers, but they have serious economic consequences, as at large scale slaughterhouses, where number of annual slaughters is high, just a few tenth parts percentage reduction in water holding capacity results in dramatic losses.

In the evaluation of gender on meat quality barrows and sows were compared. Findings did not reveal any difference between the genders considering meat quality ($P>0.05$), which is in line with the former studies in the literature (*Ellis et al.*, 1996, *Leach et al.*, 1996, *Lindahl et al.*, 2001). According these results, when meat quality experiments are planned, there is no need to separate the genders; they can be handled in one group.

4.2. Evaluation of year and month effect on meat quality

I studied the year and month effect in HLW and HL breeds. In the studied 10 years period, remarkable development has occurred in the HL breed concerning the pH_1 values. This increase is clearly caused by the selection program to eliminate the stress susceptibility from this breed. This process started in the beginning of the 90s', while since 1998 it was obligatory to supervise stress genotype, and breeding of the susceptible nn and Nn genotypes was forbidden.

Considering the changes occurred in the pH_1 and pH_2 levels due to elimination of stress susceptibility, it can be declared that PSE character caused by stress susceptibility is mainly modified by the pH_1 value. While pH_1 has improved with more than one tenth for three years, pH_2 has shown only 0.03 improvement. In the meantime, incidence of PSE character (PSE %) reduced close to zero in the examined period.

However, continuous drop in the water holding capacity was observed in both breeds. In the last 10 years, cooling loss has increased with almost 0.5 %. So, elimination of stress susceptibility in the HL breed has not implied the improvement of WHC.

In the 10 years I examined, no clear tendency was found in the changes of meat colour. While considering the results of *Wittmann et al.* (1985), world wide tendency seems to be true for our Hungarian breeds, i.e. colour of pig meat becomes more and more light continuously.

The month of slaughtering has shown significant influence on each measured meat quality parameters in both breeds. pH_1 and pH_2, as well as the colour has changed significantly month by month, but similar to the breed effect these changes were minimal for the meat industry. However, meat colour is usually darker in the winter months. This finding was proven in several former studies (*Küchenmeister et al.*, 2000, *O'Neill et al.*, 2003., *Guardia et al.*, 2004).
I found that during the summer months, WHC of the meat was remarkably lower, than in winter, which was clearly confirmed by the significant increase of cooling loss. Both breeds showed the highest cooling loss in July (HLW: 2.541±0.758; HL: 2.585±0.623) and August (HLW: 2.559±0.648; HL: 2.531±0.641). The findings have revealed the best WHC values in January (HLW: 2.139±0.680) or in March (HL: 2.229±0.565).

4.3. Effect of transportation and lairage on stress status and meat quality

According to the changes in the analysed physiological parameters, transportation is revealed to cause marked stress in the animals. It is confirmed by the increased cortisol level (138.78±41.36 nmol/l ⇨ 170.12±60.13; $P<0.001$) resulting from the activation of the hipotalamo-pituitary-adreno-cortex axis. Transportation influenced also the antioxidant status of the animals. Consequent to the remarkable oxidative load, the level of GSH was reduced significantly both in the blood plasma (2.58±0.56 µmol/g protein ➪ 2.10±0.79; P<0.05) and in the red blood cell haemolysate (4.09±1.16 µmol/g protein. ➪ 2.16±0.66; P<0.001). The reduced GSH level might be explained with its reduced synthesis (the lack of amino acid intake) and by its non-enzymatic oxidation. Similar reduction was experienced in the Vitamin C concentration (126.54±50.28 µg/ml ➪ 102.31±25.25; P<0.05).

However, lairage time has no or minimal influence on biochemical parameters in the blood and on meat quality parameters. Comparing the two lairage time no significant changes were found in the mentioned parameters except GSHPx activity (P<0.05) in the erythrocyte haemolysate.

Based on the results, it can be concluded, that in stress resistant pigs lairage time – if it exceeds one hour – does not have measurable effect on meat quality. While formerly lairage time was thought to be a major modification factor (*Wittmann et al.*, 1991; *Warris*, 1998), today more and more authors report about the declining role of it. There are several publications initiate reduction of lairage time to 2-3 hours (*Milligan et al.*, 1998, *van der Wal et al.*, 1997, *Warris et al.*, 1998), as after approximately two hours of lairage the animals calm down and fighting declines (*van del Wal et al.*, 1997). Besides these, *Nanni Costa et al.* (2002) and *Guardia et al.* (2005) suggest, that too long lairage time might increase scratches on the skin and frequency of DFD character. My results measured at the 45th minutes predicted the incidence of DFD character, while data measured at the 24th hour, generally used for separation of DFD meat, have not confirmed this. My results on meat quality parameters are in line with the data reported by *Aaslyng et al.* (2001), though they could not show any changes in the 45th minutes parameters, and did not examine stress parameters.

4.4. Effect of electric goad on stress status and meat quality

Remarkable difference was revealed in the serum cortisol level of pigs of the two groups driven with different methods: blood hormone concentration was much higher in the animals driven without using goad as compared to ones driven with electric goad (162.39±41.18 vs. 122.75± 48.11). This could be explained by the time required for driving the whole group through the stunning as driving 20 pigs through stunning requires 4 minutes with and 16 minutes without using goad.

Lactate concentration in the blood plasma has increased almost threefold in both groups, while the animals were driven stunning. This proves that stress induces anaerob glycolysis even before stunning, in the alive animals. Stimulating effect of electric goad on metabolism of muscle is supported by the higher plasma lactate concentration revealed in two groups driven with goad as compared to the initial value (12.90±5.02 vs. 10.45±4.11), though this difference was not significant. *Küchenmeister et al.* (2004) reported similar results, as they have found 1.5 fold increase in blood plasma lactate concentration, when electric goad was used.

At the same time, the use of the electric goad has caused remarkable oxidative load, which is proven by the increased lipid peroxidation level in the erythrocyte haemolysate (MDA: 7.86±1.96 ⇨ 10.00±1.42; $P<0.05$), and by the changes found in the antioxidant defence. Using electric goad caused significant increase in the reduced glutathione concentration of the erythrocyte haemolysate (2.94±0.35 ⇨ 3.12±0.25; $P<0.05$).

Although using of electric goad caused significant differences in many biochemical parameters, no difference in the meat quality was found. This agrees with the results of *Hambrecht et al.* (2005), who has not found differences in pH, meat colour or water holding capacity even after notable longer use of goad.

According to my results, there are several arguments for and against using goad. Several data are available in the literature on enhancing effect of goad on muscle metabolism and on its consequent effect on *post mortem* drop of the pH. When animal welfare is considered, use of goad is also not tolerated. However, it has to be also considered that it is practically impossible to drive stunning animals at large slaughterhouses at a pace required by the rhythm of stunning and further processing. Naturally, only automated systems are to be used, in which driving to stunning is done without human activity.

Pros for using goad are the following ones: Same number of animals can be driven to stunning takes one quarter period of time necessary for driving the animals without goad. Results of my studies clearly suggest, that long driving period is undesirable as permanent high cortisol concentration occurs in the blood consequent to the durable and increased activation of hipotalamo-pituitary-adreno-cortex axis. However, this hormone has vasoconstrictor effect, which is especially detrimental during bleeding process.

4.5. Effect of slaughtering technology on stress status and meat quality

When small- and large-scale slaughtering technologies were compared significant difference was found in lactate concentration of blood plasma (A: 9.74±3.23; B: 13.09±4.00; $P<0.01$). In case of the large-scale group the longer way from the lairage pen to the stunning device requires more muscle work from the animals, raised indoor, restricted conditions. No significant changes were caused by the slaughtering technology in lipid peroxidation processes and concentration/activity of antioxidant defence parameters.

Slaughtering technology has significant effect on meat quality. I found remarkable quality differences ought to different slaughtering techniques: small-scale technology seems to be more advantageous in case of pH (pH_{1ham} A: 6.47±0.14; B: 6.28±0.21; $P<0.01$), drip loss (A: 4.05±0.99 vs. 4.81±1.22) and meat colour, though in this parameter the difference was minimal. These results can be explained by the differences in the speed of the two slaughtering technologies. The small-scale slaughtering was faster, the carcasses were conveyed to the cooler earlier, which stopped the pH decline sooner and resulted in a higher pH, than in large-scale slaughtering.

Altogether, the results of this experiment have revealed important role of slaughtering technology as a complex factor in meat quality considering the parameters measured at 45^{th} minutes and 24 hours after slaughtering. Obviously, different results are obtainable, when a pre-slaughter parameter is studied in small- or large-scale slaughtering technology. Each slaughtering technology processes, which increase carcass temperature (like scalding, singeing) or cause delay of cooling, have detrimental effect on meat quality as result in lower final pH, paler colour, reduced water holding capacity.

4.6. Relationship between meat quality parameters, measurement and evaluation of meat quality

The different meat quality parameters are not independent from each other, there is a relationship among them. The correlation between slaughter value and meat quality is confirmed in stress susceptible animals, but not in stress resistant ones. In the above mentioned experiments, several meat quality parameters were measured in a large number of animals, thus I had the possibility to evaluate the correlation between them, and to declare their suitability to describe meat quality.

The parameters measured at 45^{th} minute, such as the pH and meat core temperature, findings reveal a moderate, negative correlation ($r=0.46$). It means that at higher temperature the intensity of post mortem metabolism is increased and the pH decline is accelerated. The pH_{24} shows correlation with each parameters describing the final meat quality. The strongest correlation was found with meat lightness value (r=-0.83), which means that a longer post mortem metabolism can cause a paler meat. The WHC shows moderate correlation with meat lightness value (r=0.67), and with ultimate pH_2 (r=-0.57), thus low pH value and pale meat usually imply exudative character of the meat.

Low correlation coefficients were found between meat quality and slaughter value (lean meat content, backfat thickness). On the other hand, when the effect of loin weight (A: small < 4kg; B: medium 4-5 kg; C: large > 5 kg) on meat quality was examined I found that higher loin weight usually cause inferior meat quality. The larger was the loin the lower pH_1 (A: 6.11±0.26; B: 6.03±0.22; C: 6.00±0.21; P<0.001) and pH_2 (A: 5.80±0.16; B: 5.77±0.14; C: 5.75±0.13; P<0.001) values were measured, the paler was the meat (A: 67.01±5.58; B: 66.77±5.761; C: 65.83±5.908; P<0.001) the more inferior was the water holding capacity (A: 2.247±0.585; B: 2.326±0.598; C: 2.392±0.603; P<0.001). This tendency agrees with the one experienced in stress susceptible animals, however the effect is weaker. Usually large loin has moderate cooling properties, which can cause longer pH decline than in small one.

It is well known, that the different meat parts of the carcass can have different quality, but in my studies differences within a muscle have revealed. Considering my findings measuring point has significant role on pH_{24} (P<0.05) and on red colour (a*, P<0.01). Usually, the medial parts of the loin show lower pH and lighter colour, than lateral parts as a consequence of differences in the cooling properties. Interior parts cool down slower than lateral ones, causing inferior meat quality at such measuring points.

According to my results, suitability of the sensory analyses carried out in the national pig tests to evaluate meat quality is uncertain. In the statistical analyses I found that the judge mainly evaluates the meat solely by its colour (r=0.35-0.44). This is the reason why PSE meat is judged undesirable in most of the evaluations, while DFD meat has not only considered to be acceptable, but even got higher scores in judging than normal quality meat. Comparing the DFD meat with the normal quality, the previous one got a higher sensory score (2.941±0.265 vs. 2.869±0.469), because of its darker colour.

5. NEW SCIENTIFIC RESULTS

1. I have declared that the breed has minimal effect on pH, meat colour and water holding capacity, when dominant genes, enhancing stress susceptibility, are eliminated from the population with targeted selection, and this effect is negligible for the meat processing industry.
2. According to my results, it can be proven that primary processing technology has more remarkable effect on carcass pH and WHC, than the breed or the conditions preliminary the slaughtering.
3. Length of lairage before stunning has no measurable effect on final meat quality in large-scale slaughterhouse technology, when it is longer, than one hour after transportation.
4. Considering the results of my studies, time length of driving from lairage to stunning has crucial role to reduce stress, while equipment of driving has omissible effect.
5. I have found that pH measured 45 minutes after stunning is essential, but not sufficient parameter to determine PSE character of meat. For this purpose, water holding capacity has to be measured as well.
6. Due to my studies it can be declared that negative correlation is present between loin-size and technological meat quality (pH, colour, WHC) even in stress resistant stock.

Author's publications related to the thesis

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