

AN INFLUENCE OF DUROC BREED IN PATERNAL POSITION ON CARCASS VALUE AND BUSINESS CLASSIFICATION BY SEUROP SYSTEM IN HYBRID PIGS

Libor Sládek, Eliška Dračková, Vladimír Mikule, Eva Sobotková

Department of Animal Breeding, Faculty of AgriSciences, Mendel University in Brno, Zemědělská 1,
Brno 613 00, Czech Republic

Abstract

The aim of this study was to establish the impact of genotype on the carcass value of tested slaughter pigs of the hybrid combination (Czech Large White x Czech Landrace) x Duroc. The slaughtered test animals had an average slaughter weight of 119.68 ± 12.37 kg, the average lean meat portion of the carcasses established by classification was 56.20 ± 3.15 %, the average backfat thickness was 17.13 ± 4.10 mm. An average 3.63% of intramuscular fat in the longest back muscle was found in all the monitored slaughter pigs. The highest percentage of carcass pigs 54.3 % (398 animals) were classified in business class E with 57.51 ± 1.32 % of lean meat portion, 115.15kg of an average slaughter weight. The lowest number of pigs (3 animals) were classified into business class O with 43.83% of lean meat portion. From results it is evident that with decrease of lean meat portion the slaughter weight of carcass pigs was growing. Carcass pigs classified into business class E reached the highest average price (32.86 CZK) per 1 kg of carcass body. A low negative correlation of $r = -0.25$, statistically conclusive on the level of importance of $P < 0.05$, was registered between slaughter weight and lean meat content. A very high negative correlation of $r = -0.95$, statistically conclusive on the level of importance of $P < 0.001$, was established between the thickness of backfat thickness and the lean meat portion.

Keywords: Duroc, lean meat portion, backfat thickness, intramuscular fat

1. INTRODUCTION

Hybridisation programs have the goal of achieving various hybrid populations with the greatest possible phenotype level of reproductive and productive traits, i.e. including carcass value. Hybridization is a method which uses required differences among breeds and heterosis to improve efficiency in pig breeding (Wysokińska and Kondracki, 2013). In many countries domestic pigs were hybridized with different commercial breeds to improve their efficiency (Miao et al., 2009; Jiang et al., 2011; Franco et al., 2014; Muhlisin et al., 2014). Duroc breed is usually used in paternal position because of their higher feed conversion (Raj et al. 2010), excellent growth intensity (Suzuki et al. 2003), an improved average daily gain (Latorre et al., 2003) and higher content of intramuscular fat (IMF), which is an important factor for meat quality (Fjelkner-Modig and Tornberg, 1986; Barton-Gade, 1988; Warriss et al., 1990).

This includes the quantitative and qualitative aspects of production of pork, the popularity of which with consumers is also based on its typical flavour, which is significantly affected by intramuscular fat. According to Miara et al. (2014) use of suitable meat breeds of pig during hybridisation is a very important factor for improving the economic properties of pork. The proportion of the meaty parts and fatty parts changes with the increasing slaughter weight of the pigs, thereby changing the slaughter value. Kim et al. (2005) Alvarez-Rodríguez and Teixeira (2019), Wang et al. (2019), Lertpatarakomol (2019) and a number of others have studied the impact of slaughter weight on the carcass value of hybrid pigs. Genotype and feeding of pigs have a big influence of carcass value (Waylan et al., 2002; Apple et al., 2003; Berg et al., 2003).

In his study Latorre et al. (2004) states a final slaughter weight of up to 124 kg from the aspect of lean meat portion and the quality of the pork, for final hybrids intended for slaughter. The yield from pigs of above 124 kg slaughter weight is significantly reduced, particularly the proportion of muscle and the quality of the pork. Attention in the field of breeding pigs recently focused more on the quality of the carcass, expressed by the proportion of lean meat, but the required sensory, nutritional, culinary and

technological properties of the pork were neglected. The technological and culinary aspect could include the practically very important parameter of intramuscular fat (marbling), which affects the juiciness, tenderness and flavour of the pork. Meat with little fat has a bland flavour, is tough and dry.

According to the opinion of Wang et al. (2019) the content of intramuscular fat has been reduced in recent years as a result of the process of breeding for increased lean meat portion and more primitive breeds of pig achieve a higher IMF content. The effort to increase IMF content in pork from breeds of pig farmed in conventional facilities and thereby the better flavour of pork is based on these findings. According to Ding et al. (2019) intramuscular fat (IMF) is an important qualitative property of pork, which affects the sensory properties and nutritional value of pork. Font-i-Furnols, et al. (2019) found on the basis of his observations that intramuscular fat content depends on the sex, genotype and nutrition of the pigs. Hovenier et al. (1993) considers the most important properties affecting the quality of meat to be the intramuscular fat content, the colour of the meat, the ability of the meat to bind free water, and the mildness and pH of the meat. According to Wang et al. (2019) the content of intramuscular fat (IMF) plays an important role on the quality of the meat. According to Suzuki et al. (2005) and Woode et al. (2008) IMF is generally considered one of the main parameters influencing the quality and sensory properties of the meat. Many studies have been devoted to the relationship between intramuscular fat content and the sensory and flavour properties of pork (Brewer et al., 2001; Rincker et al., 2008; Moeller et al., 2010). On the basis of taste tests a 2.5% intramuscular fat content is recommended in the longest back muscle, as Bejerholm and Barton Gade (1986) also state. Meat without sufficient marbling is considered not juicy or flavourful enough and not very acceptable to consumers. An excessive intramuscular fat content is also refused, because it increases the energy in the meat too much.

2. MATERIALS AND METHODS

Operational testing of hybrid pigs was used to obtain the monitored indicators. F₁ generation hybrids of Czech Large White x Czech Landrace (CLW x CL) were used as mothers and were bred by insemination to boars of the Duroc (D) breed. 733 pigs intended for slaughter in the experiment. Together 78 pigs were used for determination of quantitative traits of carcass value. Normal commercial feed mixtures were used to fatten the animals.

The tested animals were slaughtered after fattening was completed. After being slaughtered the weight of the carcass was established and the slaughter weight of the slaughtered pig was established using a coefficient. The pig carcasses were weighed after being slaughtered using an electronic scale on site before the refrigeration unit. The lean meat portion of the slaughtered pigs was established by invasive methods using a Fat-O-Meater (FOM). The animal's lean meat portion was always evaluated on the left half, when a probe was inserted between the 2nd and 3rd before-last rib, 70 mm laterally from the line of the halving cut. Data about lean meat portion (%), muscle thickness (mm) and backfat thickness (mm) was obtained from each measurement of the carcass.

The lean meat portion in the carcass is calculated using the following formula:

$$Y = 70.28164 - 0.75376 \times S + 0.00270 \times M$$

whereas: Y – estimated percentage of muscle mass (lean meat) in the carcass,

S – thickness of the backfat (including skin) in mm, measured 6.5 cm from the longitudinal axis of the carcass, between the second and third to last rib.

M – thickness of the muscle in millimetres, measured at the same time and in the same place as S

This formula is valid for carcasses weighing between 60 and 120 kilograms.

Tested carcass pigs were classified into separated business classes by SEUROP system.

In a scope of carcass value results monitoring the length of carcass body in tested animals was measured from cranial edge of the first rib till cranial edge of symphysis.

For determination of PSE defect of pork pH₁ was measured in *musculus longissimus lumborum et thoracis* (MLLT) 45 minutes after slaughter. Value of pH was determined with pH – metre 340/ SET-1 (WTW, Germany) with puncture electrode.

For the purpose of this experiment one half of the slaughtered pig was always butchered into the main cuts of meat (shoulder, loin and ham) and each individual cut was weighed on the electronic scale.

When butchering the pig carcasses 300 g samples from the longest back muscle were taken from the animals at the point of the last thoracic vertebra to assess the quality of the meat. In relation to the qualitative indicators in the MLLT and specification of the IMF content, which took place in a laboratory at Mendel University in Brno at the Institute of Animal Breeding.

On the basis of the qualitative indicators of pork we focused our work on determining the percentage of IMF in the MLLT, drip loss and the colour of the pork.

Intramuscular fat content was determined in a laboratory using the method of extraction by ether according to Soxhlet.

Drip loss of pork was determined by a sample of approx. 300 g being collected 24 hours after slaughter of the pig and this being placed in a plastic bag. The sample was weighed on a laboratory scale and then placed in a refrigerator for 24 hours at a temperature of 2 – 5 °C. The next day the sample was weighed again and the result was expressed as the difference in weight before and after placement in the fridge. The drip loss of meat is expressed in %.

Parameters in the CIELab colour system were monitored in order to evaluate the colour of the pork, whereas lightness (L*), the proportion of the red (a*) and yellow (b*) spectrum, as determined by a Konica Minolta CM - 2600d spectrometer (Konica Minolta, Japan), were monitored. In order to ensure standard conditions when taking these measurements the gauge aperture was set to 8 mm, the source of daylight was – D65, 10° standard observer angle and SCI mode were set.

STATISTICA 12 software was used for statistical evaluation. A Scheffe test was used to determine the conclusiveness of differences between groups and the probability of differences was determined at a level of $P < 0.05$ and $P < 0.001$. Pearson's correlation was used to establish a relationship between selected slaughter value indicators.

3. RESULTS AND DISCUSSION

Table 1 gives the results of slaughter weight indicators for all tested slaughtered pigs of the hybrid combination (CLW x CL) x D. The slaughtered test animals had an average slaughter weight of 119.68 ± 12.37 kg, the average proportion of lean meat of the carcasses established by classification was 56.20 ± 3.15 %, the average backfat thickness was 17.13 ± 4.10 mm. Bahelka et al. (2007) registered a lower proportion of lean meat (55.13 %) in slaughtered pigs of an average slaughter weight of 107.92kg in their experiment. Lertpatarakomol (2019) et al. states that the Duroc breed is extensively used for three-breed utility hybridisation in the following combination of breeds: (Large White x Landrace) × Duroc. Their slaughtered test animals of the hybrid combination (Large White x Landrace) × Duroc at a slaughter weight of 101.67 kg had backfat thickness of 18.84 mm.

In their experiment with the hybrid combination (Large White x Landrace) x Large White, Conte et al. (2011) found that the slaughtered pigs had backfat thickness of 12.2 mm at a slaughter weight of 105 kg. Suzuki et al. (2003) recorded a greater backfat thickness of 18 mm at 109 kg slaughter weight in their experiment for the hybrid combination (Landrace x Duroc) x Duroc. Cámara et al. (2016) determined a much thicker layer of backfat of 23.3 mm in slaughtered pigs of the hybrid combination (Landrace x Large White) x German Pietrain at a slaughter weight of 106.1 kg in their experiment. Peinado et al. (2008) gives a much higher backfat thickness (23 mm) at a slaughter weight of 114kg for the hybrid combination of (Landrace x Large White) x (Pietrain x Large White) pigs in his work than in our experiment, when backfat thickness of 15.67 mm was determined at a slaughter weight of 114.34 kg.

The average IMF content in our test animals of the hybrid combination (CLW x CL) x D was determined on the level of 3.63 ± 1.29 %. Matoušek et al. (2006) found low values of intramuscular fat in their experiment with the hybrid combination (Czech Landrace x Czech Large White) x (Duroc x Pietrain) (1.56 %), (1.16%) for the combination (Czech Landrace x Czech Large White) x Large White Paternal and (0.95%) for the combination (Czech Landrace x Czech Large White) x (Large White Paternal x Pietrain). Gajic and Isakov (2000) determined 2.93 % IMF in the meat of Mangalica breed pigs, 1.93 % in Yugoslavian Meat Pigs and 1.67% in the Belgium Landrace 1.67 %. These differences were highly conclusive. (Sellier and Monin, 1994) registered the conclusive impact of breed on IMF content, the bindingness of water, the colour and tenderness of the meat. In their publication Suzuki et al. (2005) also mention that the Duroc breed achieves the highest IMF content values compared to other breeds of pig.

Lo et al., (1992), Armero et al. (1998) also gave a higher intramuscular fat content in the Duroc breed compared to the Large White and Landrace breeds. Hybrids with the Duroc breed also have a higher content of this fat than hybrids of other breeds. Suzuki et al. (2003) included the following breeds of pig in his experiment: 1. Berkshire, 2. Duroc and hybrid breeds of the combinations: 3. Landrace x Berkshire, 4. Landrace (L) x Duroc. A significant difference in evaluation of intramuscular fat content was determined between the slaughtered pigs depending on group (3.18 % and 4.25 % and 3.34 % and 4.77 %). In relation to the parameters of the colour of the meat, the significance of differences on the level of $p < 0.05$ was not proven ($L^* - 48.03; 48.25; 48.27$ and 49.05).

A higher average value (58.59 ± 3.34) of the lightness of the colour of meat L^* was determined in our test slaughtered animals than Suzuki et al. (2003) gives in his study for test pigs. Lertpatarakomol et al. (2019) had a lower value of the lightness parameter L^* (51.19) in pigs of the hybrid combination (Large white x Landrace) x Duroc and a practically identical percentage of the yellow spectrum b^* (11.47), in our experiment we measured b^* 11.68.

In our test pigs the average values of weight of the main meaty parts were established as: shoulder 7.27 kg, neck 4.44 kg, loin 5.14 kg and ham 13.78 kg.

Table 1. Carcass value indicators in the tested animals of the hybrid combination (CLW x CL) x D

Traits	Mean	SD	V (%)	Min - Max
SW (kg)	119.68	12.37	10.28	92.13-145.08
CW (kg)	93.14	9.63	10.28	71.70-112.90
LMP (%)	56.20	3.15	5.61	48.70-63.50
MT (mm)	66.00	10.04	15.14	7.90-83.40
BF (mm)	17.13	4.10	23.70	4.80-27.00
IMF (%)	3.63	1.29	35.47	1.62-8.20
DL (%)	1.64	0.52	31.71	0.61-3.32
L^*	58.59	3.34	5.71	49.19-65.95
a^*	0.65	1.24	91.80	-2.71-4.78
b^*	11.68	1.16	9.95	8.45-14.41
MMP (kg)	30.63	2.88	8.27	23.82-37.24
SHDR (kg)	7.27	0.85	11.68	5.50-9.54
NECK (kg)	4.44	0.49	10.93	3.25-5.50
LOIN (kg)	5.14	0.66	12.83	3.36-6.52
HAM (kg)	13.78	1.39	10.07	11.00-16.50

SD: standard deviation, V: coefficient of variation

SW: slaughter weight, CW: carcass weight, LMC: lean meat portion, MT: muscle thickness, BF: backfat thickness, IMF: intramuscular fat content, DL: Drip loss, Meat colour: L*: Lightness parameter, b*: Yellow spectrum percentage, a*: value of red spectrum in the meat, MMP: main meaty parts, SHDR: weight of shoulder, NECK: weight of neck, LOIN: weight of loin, HAM: weight of ham

In Table 2 and Figure 1 there are data of classification into business classes by SEUROP system of carcass hybrid pigs – combination (CLW x CL) x D.

From results it is evident that with decrease of lean meat portion the slaughter weight of carcass pigs was growing. Nakev and Popova (2019) reached the same finding in their study. They recorded important differences in slaughter weights of carcass pigs according to separated classes of SEUROP. Carcass pig bodies with higher lean meat portion reached lower slaughter weight. Slaughter weight in class S was statistically conclusively lower in comparison with slaughter weight in classes E, U, R and O.

From Table 2 it is evident there were statistically conclusive differences in lean meat portion among business classes of SEUROP.

The highest percentage of carcass pigs 54.3 % (398 animals) were classified in business class E with $57.51 \pm 1.32\%$ of lean meat portion, 115.15kg of an average slaughter weight with an average price 32.86 ± 1.99 CZK per 1 kg of carcass body. Together 102 of carcass pigs (13.9%) were classified into business class S with an average lean meat content of 61.10%. The lowest number of pigs (3 animals) were classified into business class O with 43.83% of lean meat. Nakev and Popova (2019) analysed 100 762 of carcass pigs between years 2012 – 2015 in Bulgaria. Study was aimed on classification of carcass pigs into business classes of SEUROP system. They mention lower growth of carcass bodies in a class S and decrease in classes U and R for 13.89% and 0.89%. In class E there was recorded growth from 65.45% in 2012 to 76.49% in 2015.

In Hungary the highest amount of carcass bodies is classified into class E (52%), 32% into class S, 10% into class U and 1.2% into classes R/O/P (Szöllösi et al. 2017).

Table 3 shows carcass pigs classified into business class E reached the highest average price (32.86 CZK) per 1 kg of carcass body.

In business class S the price for 1 kg of carcass pig body was 32.41 CZK. According to David et al. (2016) carcass pigs with higher lean meat portion over 57.5% have advantaged price. According to Pulkrábek et al. (2015) carcass value expressed by lean meat percentage has a biggest influence on price of carcass pigs. According to projection with increase of backfat thickness the portion of lean meat was decreasing. The highest value of backfat thickness 33.3 ± 2.17 mm was reached in class O with 43.83% of lean meat, on the contrary the lowest value 8.64 ± 0.89 mm was in carcass bodies in class S. To determine pork meat quality pH₁ in carcass body was measured 45 minutes after slaughter. There were no noticeable differences among measured values. Average values were in an interval from 6.25 ± 0.32 to 6.38 ± 0.27 . Vitek et al. (2009) studied chosen traits of meat quality in their study. An average value of pH₁ reached in business class S 6.01 ± 0.165 , in class R 6.43 ± 0.063 . Content of IMF was slightly increasing with decrease of lean meat portion. The longest carcass body (862 ± 5.20 mm) was found in pigs of class O, the shortest (832 ± 4.18 mm) in carcass pigs in class S.

Table 2. Classification of carcass pigs of hybrid combination (CLW x CL) x D into business classes by SEUROP system

Business class and lean meat portion in %	n	Slaughter weight (kg)	Backfat thickness (mm)	Muscle depth (mm)	Lean meat portion (%)
		X ± SD	X ± SD	X ± SD	X ± SD
S (60 and more)	102	99.82 ± 13.08	8.64 ± 0.89	55.42 ± 7.77	61.10 ^{a,e,h,j} ± 0.6
E (55-59.9)	398	115.15 ± 15.75	13.89 ± 2.04	60.12 ± 9.34	57.51 ^{b,f,i,j} ± 1.32
U (50-54.9)	203	117.20 ± 15.58	19.84 ± 1.94	58.25 ± 10.70	53.35 ^{c,g,h,i} ± 1.34
R (45-49.9)	27	118.76 ± 15.49	28.12 ± 2.02	53.39 ± 11.75	47.49 ^{d,e,f,g} ± 1.53
O (40-44.9)	3	120.48 ± 2.62	33.3 ± 2.17	52.33 ± 5.12	43.83 ^{a,b,c,d} ± 1.42

X – arithmetic mean, SD – standard deviation, n - number

a,b,c,d,e,f,g,h,i,j: same letters are significantly different at P<0.001

Table 3. Price and carcass value of pigs of hybrid combination (CLW x CL) x D classified into business classes by SEUROP system

Business class and lean meat portion in %	n	Price per 1 kg of carcass (CZK)	pH ₁	Length of carcass body (mm)
		X ± SD	X ± SD	X ± SD
S (60 and more)	102	32.41 ± 1.85	6.37 ± 0.29	832 ± 4.18
E (55-59.9)	398	32.86 ± 1.99	6.36 ± 0.26	844 ± 3.83
U (50-54.9)	203	30.74 ± 1.84	6.38 ± 0.27	838 ± 4.70
R (45-49.9)	27	27.41 ± 1.91	6.25 ± 0.32	857 ± 5.50
O (40-44.9)	3	26.30 ± 0.41	6.32 ± 0.26	862 ± 5.20

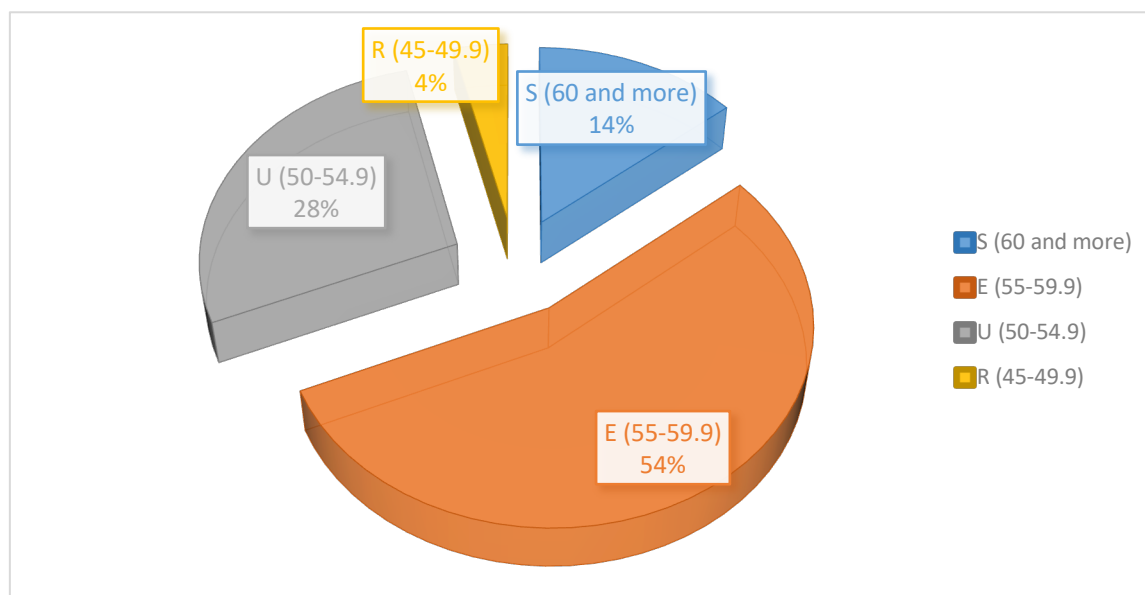


Fig. 1. Business classification of carcass pigs of tested hybrid combination (CLW x CL) x D by SEUROP system

Table 4 gives the correlations between the selected slaughter weight indicators of final hybrids intended for slaughter. A low negative correlation of $r = -0.25$, statistically conclusive on the level of importance of $P < 0.05$, was registered between slaughter weight and muscle mass. A nearly identical correlation ($r = -0.20$) was determined between slaughter weight and muscle mass in the study by Sládek et al. (2018).

A very high negative correlation of $r = -0.95$ was found between the thickness of the backfat and the lean meat portion. In her study Kernerová et al. (2000) also found a correlation coefficient of $r = -0.91$ between the thickness of the backfat and the lean meat portion. Mrode and Kennedy (1993) give a correlation of $r = -0.87$ between the thickness of the backfat and the lean meat portion. Lopez et al. (2019) also showed high negative correlation ($r = -0.93$) between the thickness of the thickness of the backfat and the lean meat portion. A statistically conclusive $P < 0.05$ positive correlation of 0.27 was found between slaughter weight and the thickness of the backfat. A statistically conclusive positive correlation of $P < 0.05$ was ($r = 0.25$) established between IMF content and the lightness parameter (L^*) of pork. A very stastically high $P < 0.001$ positive correlation (0.58 resp. 0.45) was stated in pork colour indicators between the percentage of yellow spectrum (b^*) and the lightness parameter (L^*), or the red spectrum value (a^*). A very high statistical $P < 0.001$ positive correlation (0.83; 0.43; 0.51; 0.88) was registered between slaughter weight and the weight indicators of the main cuts of meat (shoulder, neck, loin and ham). A very high statistical $P < 0.001$ positive correlation was also determined between the individual weight indicators of the main cuts of meat.

Table 4. Determined correlations between selected carcass value indicators.

Traits	2	3	4	5	6	7	8	9	10	11
1. SW (kg)	-0.25*	0.27*	0.06	-0.01	0.10	0.18	0.83***	0.43***	0.51***	0.88***
2. LMP (%)		-0.95***	-0.09	0.13	-0.23*	0.05	0.06	-0.02	-0.01	-0.13
3. BF (mm)			0.12	-0.13	0.21	-0.05	-0.04	0.02	0.01	0.18
4. IMF (%)				0.25*	-0.04	0.16	0.11	-0.18	-0.04	-0.01
5. L^*					-0.09	0.58***	0.05	0.19	-0.01	-0.01
6. a^*						0.45***	0.05	-0.01	0.05	0.07
7. b^*							0.25*	0.11	0.15	0.16
8. SHDR (kg)								0.46***	0.55***	0.87***
9. NECK (kg)									0.52***	0.49***
10. LOIN (kg)										0.51***
11. HAM (kg)										

significantly different at * $P < 0.05$, *** $P < 0.001$

SW: slaughter weight, LMP: lean meat portion, BF: backfat thickness, IMF: intramuscular fat content, Meat colour: L^* : Lightness parameter, b^* : Yellow spectrum percentage, a^* : value of red spectrum in the meat, SHDR: weight of shoulder, NECK: weight of neck, LOIN: weight of loin, HAM: weight of ham

4. CONCLUSION

On the basis of the achieved results, we can state that the tested hybrid combination (Czech Large White x Czech Landrace) x Duroc has demonstrated very high meat quality, expressed by intramuscular fat content (3.63 %) in the longest back muscle.

The highest number of carcass pigs of hybrid combination (Czech Large White x Czech Landrace) x Duroc were classified into business class E with 57.51% of lean meat portion, 115.15 kg of an average slaughter weight and with price 32.86 CZK per 1 kg of carcass body. Carcass pigs classified into business class E reached the highest average price (32.86 CZK) per 1 kg of carcass body.

REFERENCES

- Álvarez-Rodríguez J, Teixeirab A 2019, Slaughter weight rather than sex affects carcass cuts and tissue composition of Bisaro pigs. *Meat Science*, 154: 54–60.
- Apple JK, Boger CB, Brown DC 2003, Effect of feather meal on live animal performance and carcass quality and composition of growing-finishing swine. *Animal Science*, 81: 172-181.
- Armero E, Flores M, Barbosa JA, Toldra F, Pla M. 1998, Effects of terminal pig sire types and sex : On carcass traits, meat quality and sensory analysis of dry-cured ham. Proc 44th Int. Cong. *Meat Science and Technology*, Barcelona, 2:904-905.
- Bahelka I, Hanusová E, Peškovičová D, Demo P 2007, The effect of sex and slaughter weight on intramuscular fat content and its relationship to carcass traits of pigs. *Czech Journal of Animal Science*, 52, (5): 122-129.
- Barton-Gade P 1988. The effect of breed on meat quality characteristics in pigs. In ‘*Proceedings of the 34th international congress of meat science and technology*’, Brisbane, Australia, 568–570.
- Bejerholm C P, Barton G 1986, Effect of intramuscular fat level eating quality of pig meat. In: Proc. 32nd Eur. Mtg. *Meat. Ghent*, 389-392.
- Berg EP, Mcfaid EL, Maddock KR 2003, Serum concentration of leptin in six genetic lines of swine and relationship with growth and carcass characteristics. *Journal of Animal Science*. 81: 167 -171.
- Brewer MS, Zhu LG, McKeith FK 2001, Marbling effects on quality characteristic of pork loin chops: Consumer purchase intent, visual and sensory characteristic. *Meat Science*, 59: 153-163.
- Cámara L, Berrocoso JD, Coma J, López-Bote J, Mateos GG 2016, Growth performance and carcass quality of crossbreds pigs from two Pietrain sire lines fed isoproteic diets varying in energy concentration. *Meat Science*. 114: 69-74.
- Conte S, Boyle L A, O'connell NE, Lynch PB, Lawlor PG 2011, Effect of target slaughter weight on production efficiency, carcass traits and behaviour of restrictively-fed gilts and intact male finisher pigs. *Livestock Science*. Volume 136, Issues 2–3:169-174.
- David L, Pulkrábek J, Vališ L 2016, Realisation of pig carcasses in Czech republic, *Research in pig breeding*, 10, (2), 5-9.
- Fjelkner-Modig S, Tornberg E 1986, Intramuscular lipids in *M. longissimus dorsi* from pork, as related to breed and sensory properties. *Journal of Food Quality* 9: 143–160.
- Font-i-Furnols M, Brun A, Gispert M 2019, Intramuscular fat content in different muscles, locations, weights and genotype-sexes and its prediction in live pigs with computed tomography. *Animal*. Vol. 13, Issue: 3: 666-674.
- Franco D, Vazquez JA, Lorenzo JM 2014, Growth performance, carcass and meat quality of the Celta pig crossbred with Duroc and Landrace genotypes. *Meat Science* 96: 195–202.
- Gajic Z, Isakov V 2000, Genetic and energy effects on pig meat quality. EAAP publication No. 100, *Quality of meat and fat in pigs as affected by genetics and nutrition*. 115-118.
- Hovenier R, Novelli E, Badiani A, Selbono G, Rosa P 1993, Breeding for pig meat quality in halothane negative populations – review. *Pig News and Inform.*, 14: 17 –25.
- Jiang YZ, Zhu L, Li XW, Si T. 2011, Evaluation of the Chinese indigenous pig breed Dahe and crossbred Dawu for growth and carcass characteristics, organ weight, meat quality and intramuscular fatty acid and amino acid composition. *Animal* 5: 1485–1492.
- Kernerová N, Matoušek V, Novotný F 2000, Dopad šlechtění na úroveň masné užitkovosti u finálních hybridů. *Acta fytotechnica et zootechnica*. XIX. Dni genetiky. 148.

- Kim YS, Kim SW, Weaver MA, Lee CY 2005. Increasing the pig market weight: world trends, expected consequences and practical considerations. *Asian Australasian Journal of Animal Sciences*, 18 (4): 590-600.
- Lattore M A, Lázaro R, Gracia MI, Nieto M, Mateos GG 2003, Effect of sex and terminal sire genotype on performance, carcass characteristics and meat quality of pigs slaughtered at 117 kg body weight. *Meat Science*, 65: 1369-1377.
- Latorre MA, Lázaro R, Valencia DG, Medel P, Mateos GG 2004, The effect of gender and slaughter weight on the growth performance, carcass traits, and meat quality characteristics of heavy pigs. *Journal of Animal Science*, 2004, 82: 526-533.
- Lertpatarakomol R, Chaosap Ch, Chaweewan K, Sitthigripong R, Limsupavanich R 2019, Carcass characteristics and meat quality of purebred Pakchong 5 and crossbred pigs sired by Pakchong 5 or Duroc boar. *Asian-Australasian Journal of Animal Sciences*, 32(4): 585-591.
- Lo LL, McLaren DG, McKeith FK, Fernando RL, Novakofski J 1992, Genetic analyses of growth, real-time ultrasound, carcass and pork quality traits in Duroc and Landrace pigs: I. Breed effects. *Journal of Animal Science*. 70:2373.
- Lopez BI, Viterbo V, Song ChW, Seo KS 2019, Estimation of genetic parameters and accuracy of genomic prediction for production traits in Duroc pigs. *Czech Journal of Animal Science*, 64, (4): 160–165.
- Matoušek V, Kernerová N, Václavovský J, Vejčík A 2006, Field tests of selected combinations of final hybrids of pigs. *Acta fytotechnica et zootechnica. Slovaca Universitas Agriculturae Nitriae*, 20: 20-23.
- Miao ZG, Wang LJ, Xu ZR, Huang JF, Wang YR 2009, Developmental changes of carcass composition, meat quality and organs in the Jinhua pig and Landrace. *Animal* 3: 468–473.
- Miar Y, Plastow GS, Moore SS 2014, Genetic and phenotypic parameters for carcass and meat quality traits in commercial crossbred pigs. *Journal of Animal Science*, 92:2869–84.
- Moeller SJ, Miller RK, Edwards KK, Zerby HN, Logan KE, Aldredge TL, Stahl CA, Boggess M, Box-Steffensmeier JM 2010, Consumer perceptions of pork rating quality as affected by pork quality attributes and end-point cooked temperature. *Meat Science*, 84: 14-22.
- Mrode RA, Kennedy BW 1993, Genetic variation in measures of food efficiency in pigs and their genetic relationships with growth rate and backfat. *Anim. Prod.*, 56: 225-232.
- Muhlisin P, Lee SJ, Lee JK, Lee SK 2014, Effects of crossbreeding and gender on the carcass traits and meat quality of Korean native black pig and Duroc crossbred. *Asian–Australasian Journal of Animal Sciences*, 27:1019–1025.
- Nakev J, POPOVA T 2019, Results of the application of SEUROP for pig carcass classification in Bulgaria. *Bulgarian Journal of Agricultural Science*, 2 5 (Suppl. 1), 17 -22.
- Peinado J, Medel P, Fuentetaja A, Mateos GG 2008, Meat quality of heavy pigs destined for the dry-cured industry influence of sex and castration of females on growth performance and carcass value. *Journal of Animal Science*. 86:1410-1417.
- Pulkrábek J, David L, Vališ L, 2015. Carcass composition in selected pig hybrids in Czech republic, *Research in pig breeding*, 9, (1): 10-15.
- Raj S, Skiba G, Weremko D, Fandrejowski H, Migdał W, Borowiec F, POŁAWSKA E 2010, The relationship between the chemical composition of the carcass and the fatty acid composition of intramuscular fat and backfat of several pig breeds slaughtered at different weights. *Meat Science* 86: 324–330.
- Rincker PJ, Killefer J, Ellis M, Brewer MS, McKeith FK 2008, Intramuscular fat content has little influence on the eating quality of fresh pork loin chops. *Journal of Animal Science*, 86: 730-737.

- Sellier P and Monin G 1994, Genetics of pig meat quality: a review. *Journal of Muscle Foods*. 5:187-219.
- Sládek L, Mikule V 2018, Influences of Housing Systems and Slaughter Weight on the Market Realization of Slaughter Pigs by SEUROP Classification. *Acta Universitatis agriculturae et silviculturae Mendelianae Brunensis*. 66, 2: 389-397.
- Suzuki K, Shibata H, Kadowaki H, Abe H, Toyoshima T 2003, Meat quality comparison of Berkshire, Duroc and crossbred pigs sired by Berkshire and Duroc. *Meat Science*. 64. (1): 35-42.
- Suzuki K, Irie MM, Kadowaki H, Shibata T, Kumagai M, Nishida A 2005, Genetic parameter estimates of meat quality traits in Duroc pigs selected for average daily gain, longissimus muscle area, backfat thickness and intramuscular fat content. *Journal of Animal Science*. 83: 2058-2065.
- Szőllősi L, Molnár S, Ladányi K, Karnai L, Szűcs I 2017, Cost analysis of pig slaughtering: a Hungarian case study. *Applied Studies in Agribusiness and Commerce – APSTRACT, Center-Print Publishing House*, Vol. 11., Number 3-4., 121-130.
- Vítek M, Vališ L, Pulkrábek J, David L 2009, Jatečná hodnota a kvalita masa u finálních hybridů prasat. Sborník z mezinárodní vědecké konference konané při příležitosti 90. výročí založení MZLU v Brně. *Aktuální poznatky v chovu a šlechtění prasat*. 63
- Wang D., Young DJ, Rentfrow G 2019, Effect of different fat sources and vitamin E status/levels on growth performance, antioxidant status, carcass characteristics, fatty acid profile, and meat quality of pigs grown to heavy slaughter weight at 150 kg. *Journal of Animal Science*, Vol. 97, 2: 30-30.
- Warriss PD, Brown SN, Adams SJM, Lowe DB 1990, Variation in haem pigment concentration and colour in meat from British pigs. *Meat Science* 28: 321–329.
- Wood JD, Enser M, Fisher AV, Nute GR, Sheard PR, Richardson RI 2008, Fat deposition, fatty acid composition and meat quality. *Meat Science*, 78: 343-358.
- Wysokińska A, Kondracki S 2013, Assessment of the effect of heterosis on semen parameters of two-breed crosses of Duroc, Hampshire and Pietrain boars. *Arch. Tierz.*, 56 (7): 65-74.