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FACTORS WITH AN INFLUENCE ON A CONTENT OF INTRAMUSCULAR FAT IN PORK MEAT

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Abstract

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The aim of the study was to find out factors with an influence on a content of intramuscular fat in tested carcass pig hybrids (Czech Large White x Czech Landrace) x Duroc (CLW x CL) x D and (Czech Large White x Czech Landrace) x (Duroc x Belgian Landrace) (CLW x CL) x (D x BL). An influence of hybrid combination, sex, slaughter weight and lean meat content on a content of intramuscular fat (IMF) in *musculus longissimus lumborum et thoracis* (MLLT) was studied in an experiment with 60 tested carcass pigs. A statistical very highly conclusive difference $P \leq 0.001$ was found in measured values of IMF between both hybrid combinations (CLW x CL) x D (2.71%) and (CLW x CL) x (D x BL) (1.95%). Higher content of IMF in MLLT was determined in hogs (2.55%) in comparison to gilts (2.11%). The highest number of carcass pigs (21) was in weight group 110 – 119.9 kg with highest average IMF content on a level of 2.42%. The lowest content of IMF (2.18 %) in MLLT it was determined in pigs from weight group under 100 kg. The highest representation of carcass pigs (28.3%) it was in an animal group with 2.01 – 2.5% of IMF. The fewest animals (15%) were in group with content of IMF in MLLT more than 3.01%. The highest lean meat percentage (59.90%) was determined in a group of carcass pigs with a content of IMF 1.5% and less. On the contrary the lowest average lean meat percentage (57.26%) was determined in carcass pigs with a content of IMF 3.01 and more.

Key words: intramuscular fat, pork meat, slaughter weight, back fat thickness, lean meat portion

Introduction

In a pigs body there is a deposit of reserve fat, intramuscular fat and intramuscular fat. High importance for taste and crispness of meat has an intramuscular fat especially its intercellular portion with deposition in a form of small veins which create meat marbling (Pipek, 1995). According to Suzuki et al. (2005) and Woode et al. (2008) intramuscular fat is on of the main parameters with an influence on sensor characters and meat quality. On the contrary Rincker et al. (2008) mentions in his study that marbling has not an influence on taste characters of pork meat. It is generally accepted that an increased level of intramuscular fat (IMF) has positive influence on the sensory qualities of pig meat (Fernandez et. al., 1999). A lot of studies were concerned on a relation among content of IMF and sensor and taste characters of pork meat (Brewer et al., 2001; Rincker et al., 2008; Moeller et al., 2010; Ruść, 2011).

To reach required sensor characters after the heat working the pork meat has to have content of IMF on a level of 2% at least (Ingr, 1996). According to Baulain et al. (2000) better sensor characters are expected in pork with higher content of IMF. Meat with a lower content of IMF is marked by consumer as dry, not much crisp and juicy. Excessive content of IMF is refused too because it increases energetic content of meat. Because of the selection on a high lean meat percentage and low fat tissue portion the content of IMF decreased during past years as it is mentioned in a study about a content of IMF in pig breeds used in hybridization in the Czech Republic by Mikule et al. (2002). Recent studies in German pig population discovered average values of IMF from 1 to 1.5% which indicates that only smaller number of pigs reach required optimal level of IMF 2% (Mörlein, Link, Werner, Wicke, 2007).

An intramuscular fat content has a relation with stress susceptibility of pigs and subsequently to occurrence of PSE

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meat. Pigs with stress susceptibility have lower content of IMF and higher occurrence of PSE meat (pale, soft, exudative). On a base of tasting tests it is recommended a level of 2.5% of IMF in MLLT as is mentioned in Bejerholm and Barton Gade (1986). From pure breeds only Duroc is reaching this level (Bečková, 1997). Suzuki et al. (2005) mention in their study that Duroc is reaching the highest values of IMF content in comparison with other pig breeds. Lo et al. (1992), Armero et al. (1998) mention in their studies higher content of IMF in Duroc breed in comparison with Large White and Landrace too. Also the hybrids with Duroc have higher content of IMF in comparison with hybrids of other breeds.

A content of intramuscular fat is influenced by:

- breeds (coloured breeds have higher content of IMF in comparison with white breeds);
- genotype of animal in halotan locus (positive pigs have lower content of IMF);
- sex (hogs have higher content of IMF in comparison with boars and gilts);
- daily gain (with growing daily gain the content of IMF is growing);
- feed conversion (with better conversion a content of IMF is decreasing);
- portion of lean meat and fat tissue in carcass body (with growing lean meat portion and decrease of fat tissue the content of IMF is decreasing).

Material and Methods

The aim of the study was to find out factors with an influence on a content of intramuscular fat in tested carcass pig hybrids (Czech Large White x Czech Landrace) x Duroc (CLW x CL) x D and (Czech Large White x Czech Landrace) x (Duroc x Belgian Landrace) (CLW x CL) x (D x BL). An influence of hybrid combination, sex, slaughter weight and lean meat content on a content of intramuscular fat (IMF) in musculus longissimus lumborum et thoracis (MLLT) of carcass pigs was studied in an experiment.

To reach the aims of the experiment a field test of carcass pigs was done in chosen commercial breeding with the identical environmental conditions. Hybrids of F1 generation (CLW x CL) were used as mothers and they were insemined with portions from boar station at Velké Meziříčí (boars Duroc and hybrids D x BL were used). Tested piglets were individually marked with identification number and sex of animal was recorded to database.

In the end of fattening tested pigs were slaughtered in a slaughter house at Kostelec u Jihlavy. A weight of carcass modified body was determined after the slaughter (JUT) and a live weight of slaughter animal was counted by coefficient (1.285).

Next a lean meat portion was determined in each animal by an invasive method with Fat-o-Meater – FOM which determines and registers measured values on carcass body optically – electronically and works invasively – the probe has to be implemented in to the carcass body to determine measured values. Results of the measuring are counted on estimated portion of lean meat according to PC.

For calculation of lean meat percentage equation by Pulkrábek et al. (2000) was used:

$y = 59.86131 – 0.72930\ S\ (FOM) + 0.12853\ M\ (FOM)$,

where: y = lean meat portion in carcass modified body

S (FOM) = back fat thickness (including skin) in mm, measured 6.5 cm from longitudinal axis of carcass body between the second and third last rib

M (FOM) = muscle thickness in mm, measured at the same time and on the same place as in S (FOM).

Equation is valid for carcass modified bodies with weight between 60 and 120 kg.

During splitting of carcass modified bodies of pigs 300 g samples were taken from 60 tested animals from *musculus longisimus lumborum et thoracis* (*MLLT*) on a level of the last thoracic vertebra for evaluation of meat quality. From qualitative traits a content of intramuscular fat was determined in a laboratory of Department of animal husbandry at Mendel University in Brno. A content of intramuscular fat was determined by direct extraction according to Soxhlet with aid of ether. Determined values of IMF were recorded according to used hybrid combinations, sex, slaughter weights and meatness.

Basic statistical characteristics were determined from measured values – average, range, standard deviation, coefficient of variance, minimum and maximum. To determine statistical conclusive differences among discovered values Tukey test was used. A statistical program STATISTICA 10 was used for these reasons.

Results and Discussion

In Table 1 there are shown basic statistic characterizations of trait – intramuscular fat percentage – of two tested

Table 1
Basic statistical charakterizations content of IMF (%) according to hybrid combination

Traits	n	Average	S_x	V_x (%)	X_{min}	X_{max}
(CLW x CL) x D	30	2.71***	0.84	30.86	1.67	4.62
(CLW x CL) x (D x BL)	30	1.95***	0.82	42.00	0.99	4.19
Total	60	2.33	0.91	38.91	0.99	4.62

*** $P \leq 0.001$

pig hybrid combinations (CLW x CL) x D and (CLW x CL) x (D x BL). A statistical very highly conclusive difference P≤0.001 was found in measured values of IMF between both hybrid combinations (CLW x CL) x D (2.71%) and (CLW x CL) x (D x BL) (1.95%). Čechová and Václavovský (2003) mention in their study lower measured values of IMF in hybrid combinations (CLW x CL) x CLW - sire line (2.02%) and (CLW x CL) x (D x Pn) in comparison with our data. Šimek et al. (2004) mention in their study a content of IMF 2.3% with 54.9% of lean meat portion in hybrid combination (CLW x CL) x (D x Pn). In hybrid combination (CLW x CL) x (D x Pn) Matoušek et al. (2006) found 1.56% portion of intramuscular fat which was statistically conclusive different from values reached in combination (CL x CLW) x CLW – sire line (1.16%). Suzuki et al. (2005) in 543 Duroc pigs measured a content of IMF 4.25% during years 1995–2001.

Seifert et al. (2002) mention content of IMF higher than 2% in German Landrace, Saddle pig and their hybrids and in hybrid combination Landrace x Duroc while in Pietrain hybrids the content of IMF was under 1.5%. Kusec et al. (2005) studied a level of carcass value and meat quality in 4-breed hybrid combination (Large White x Landrace) x (Pietrain x Hampshire). They found a content of intramuscular fat on a level of 1.69% in their study.

Channon et al. (2004) aimed on an influence of Duroc breed on a content of intramuscular fat in their study. They created three groups with a different proportional representation of Duroc breed – in the first group with 0% of proportional representation of Duroc (100% Large White), in the second group with 50% of Duroc (Duroc x Large White) and in the third with 100% of Duroc breed. Pork meat from the third group with 100% of Duroc reached higher content of IMF (1.84 %, P ≤ 0.05) than pork meat from pigs with 0 and 50% of Duroc proportion (1.40%, resp. 1.25%).

Bečková (1996) in a final pig hybrid test station evaluated a proportion of intramuscular fat with a respect to hybrid combination. The highest IMF proportion 3.94 ± 0.308 % she found in combination (CLW x L) x (H x D) and the lowest 1.83 ± 0.139% in (CLW x L) x Pn. She mentions in her study that a content of IMF in final hybrids is influenced by breed combination.

In Table 2 there are basic statistical characterizations of IMF content according to sex. Higher content of IMF in MLLT was determined in hogs (2.55%) in comparison to gilts (2.11%). Matoušek et al. (2006) found out similar conclusion when determined a higher content of IMF in hogs for 0.25% in comparison with gilts (1.35%, respectively 1.09%).

Beattie et al. (1999) mention higher value of IMF content in gilts than in hogs in their study.

In Table 3 there are basic statistical characterizations of IMF content according to slaughter weight groups. The highest number of animals (21) was in weight group from 110 to 119.9 kg with the highest average content of IMF 2.42%. The lowest content of IMF (2.18%) in *MLLT* it was determined in weight group under 100 kg. In Table 4 there are values of chosen traits of carcass value according to determined groups of IMF. The highest representation of carcass pigs (28.3%) it was in an animal group with 2.01 – 2.5% of IMF. The fewest animals (15%) were in group with content of IMF in MLLT more than 3.01%. Daszkiewicz et al. (2005) compared the quality of pork (Polish Large White and Landrace) with a different IMF content and found that the increase in the intramuscular fat content (above 2%) was accompanied by a higher percentage of its dry matter content and marbling (P≤0.01). They also showed that the IMF content above 3.0 % had a positive effect on the palatability, juiciness and tenderness of pork. Holková and Bečková (1993) studied in 78 final carcass hybrids a content of IMF and they found out that a percentage of IMF is growing with a growing weight. In a weight category 91 - 100 kg of carcass modified body (112 – 123 kg of live weight) they determined 2.66% of IMF. The same conclusion is mentioned by Candek-Potakar et al. (1998). They mention in their study that with a growing slaughter weight a content of IMF is growing too.

Wajda et al. (2004) found growing level of IMF content for 0.21% with a growing slaughter weight of carcass pigs for 15 kg.

From Table 4 and Figure 1 it is evident that among the slaughter weights of carcass pigs according to IMF con-

Table 2
Basic statistical characterizations content of IMF (%) according to sex

Traits	n	Average	S_x	V_x (%)	X_{min}	X_{max}
Hogs	30	2.55	0.94	37.01	1.10	4.62
Gilts	30	2.11	0.83	39.18	0.99	4.41
Total	60	2.33	0.91	38.91	0.99	4.62

Table 3
Basic statistical characterizations content of IMF (%) according to slaughter weight

Traits	n	%	Average	S_x	V_x, %	X_{min}	X_{max}
< 100 kg	14	23.3	2.18	0.99	45.56	1.03	4.24
100-109.9 kg	12	20.0	2.34	1.28	54.56	0.99	4.41
110-119.9. kg	21	35.0	2.42	0.88	36.32	1.19	4.62
> 120 kg	13	21.7	2.35	0.40	16.86	1.63	2.97
Total	60	100	2.33	0.91	38.91	0.99	4.62

tent groups there are statistical conclusive differences. In pigs with 1.5% and lower content of IMF with an average slaughter weight 94.76 kg there was found statistical highly conclusive difference (P≤0.01) in comparison with carcass pigs with determined IMF content on a level (1.51-2%, 2.01-2.5%, respectively 2.51-3%) with average slaughter weights (114.38 kg, 111.78 kg, respectively 114.17 kg). Carcass pigs with the lowest slaughter weight (94.76 kg) reached a content of IMF on a level of 1.5% and less. In pigs with IMF percentage 1.51 – 2% with an average value 1.77% there was determined slaughter weight 114.38 kg. The highest lean meat percentage (59.90%) was determined in a group of carcass pigs with a content of IMF 1.5% and less. On the contrary the lowest average lean meat percentage (57.26%) was determined in carcass pigs with a content of IMF 3.01 and more.

In pigs with an average value of IMF content (2.74%) there was determined 57.96% of lean meat. Ruść et al. (2011) determined in hybrid combination (Landrace x Yorkshir) x Duroc in carcass pigs with 57.75% of lean meat lower content of IMF (1.95 %) than in our experiment. Carniecka-Skubina et al. (2007) confirmed that the meat with a higher IMF (> 2.51% in MLLT) is more marbled and after cooking show significantly higher palatability. Fernandez et al. (1999) in tested pig group (n=125) of hybrid combination Duroc x Landrace created groups of animals according to IMF content and they studied an influence on carcass value traits. In animal group with content of IMF (< 1.5%) determined 0.5% lean meat percentage, in group with IMF more than 3.5% determined a lean meat portion on a level 47.8%.

Among average values of back fat thickness (10.40 mm, respectively 14.15 mm) there was determined statistical conclusive difference (P≤0.05) among groups of animals with a content of IMF 1.5% compare to group with 1.51 – 2% of IMF.

In all 60 slaughtered pigs an average content of intramuscular fat in MLLT was determined on a level of 2.33% with 109.40kg of slaughter weight with 12.54 mm of back fat thickness and 58.35% of lean meat.

In Table 5 there are mentioned correlations among % IMF and chosen traits of carcass value. Low negative dependence (r = - 0.2313) it was determined between % IMF and lean meat portion. A similar correlation (r = - 0.2107) between % IMF and lean meat portion is mentioned by Sládek et al. (2004). Between IMF and back fat thickness there was determined correlation r = 0.0343. Lo et al. (1992) determined correlation (r = 0.10) between back fat thickness and IMF content in experiment with Duroc, Landrace breeds and their hybrids.

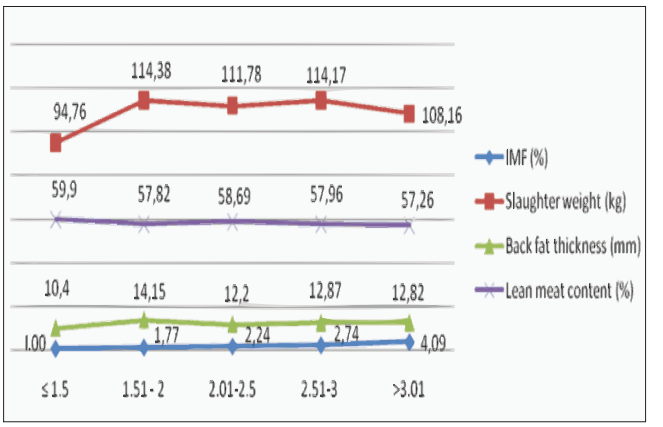

Fig. 1. Trait of carcass value according to determined IMF content (%) groups

Table 4
Trait of carcass value according to determined IMF content (%) groups

	Group 1	Group 2	Group 3	Group 4	Group 5	Total
	≤ 1.5 (n = 10)	1.51-2.0 (n=13)	2.01-2.50 (n=17)	2.51-3.0 (n=11)	>3.01 (n=9)	(n=60)
IMF, %	1.21±0.18	1.77±0.14	2.24±0.14	2.74±0.14	4.09±0.34	2.33±0.91
Slaughter weight, kg	94.76±13.18^{a,b,c}	114.38±11.13^{a}	111.78±12.94^{b}	114.17±14.13^{c}	108.16±7.97	109.40±13.69
Back fat thickness, mm	10.40±2.01^{A}	14.15±3.64^{A}	12.20±2.15	12.87±2.05	12.82±4.28	12.54±3.03
Lean meat content, %	59.90±2.24	57.82±2.73	58.69±1.98	57.96±1.62	57.26±3.57	58.35±2.50

A: P ≤ 0.05 a,b,c: P ≤ 0.01

Table 5
Determined correlation among % IMF and chosen traits of carcass value

Traits	Slaughter weight, kg	Lean meat portion, %	Back fat thickness, mm
IMF, %	0.0659	-0.2313	0.0343

Conclusion

From reached results it is possible to say that higher content of intramuscular fat in musculus longissimus lumborum et thoracis (2.71%) it was determined in carcass pigs of hybrid combination (CLW x CL) x D in comparison with (CLW x CL) x (D x BL) (1.95%). It was discovered that IMF content in hogs was higher for 0.44 % compare to gilts (2.55%, respectively 2.11%). The highest representation of carcass pigs (28.3%) it was in an animal group with 2.01 – 2.5% of IMF. The fewest animals (15%) were in group with content of IMF in MLLT more than 3.01%. The lowest content of IMF it was determined in pigs from weight group under 100 kg. The highest lean meat percentage was determined in a group of carcass pigs with a content of IMF 1.5% and less. On the contrary the lowest average lean meat percentage was determined in carcass pigs with a content of IMF 3.01 and more.

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