THE RELATIONSHIP BETWEEN INTRAMUSCULAR FAT CONTENT AND SELECTED PARAMETERS OF THE CARCASS VALUE AFFECTED BY NUTRITION DURING FATTENING IN PIGS

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Abstract

The aim of the study was to evaluate the relationship between selected indicators of the carcass value and intramuscular fat (IMF) content at the different diet in pigs. The difference was in the CFM enrichment about corn, respectively lineseed as a source of polyenic fatty acids (PUFA). Experiment show no influence of nutrition on the IMT share in the carcass. Under the influence of lineseed diet, the groups of PUFA, n-3 PUFA, PUFA:SFA ratio (saturated fatty acids) significantly ($P \leq 0.01$) increased. The n-6:n-3 ratio of PUFA and the sum of mono-fatty acid (MUFA), however, was simultaneously reduced. Changes in the carcass value parameters were insignificant. The results of correlation analysis between the IMF share and carcass value characteristics showed a positive correlation between the IMF share backfat thickness ($r=0.532$; $P \leq 0.01$), SFA ($r=0.48733$; $P \leq 0.01$). The negative correlation between the IMF share and the lean meat share ($r=-0.55095$, $P \leq 0.01$), the main meat parts share ($r=-0.45778$, $P \leq 0.05$), groups of PUFA fatty acids ($r=-0.403$, $P \leq 0.05$), PUFA n-6 ($r=-0.80555$, $P \leq 0.01$), PUFA:SFA ratio ($r=-0.43725$, $P \leq 0.05$) and n-6:n-3 ($r=-0.4224$, $P \leq 0.05$) were detected simultaneously.

Key Words: Carcass value, intramuscular fat, fatty acids, pig

Due to the traditionally high consumption of pork, especially in developed European countries, a special emphasis on the quality of this food is emphasized. The interest of consumers about the healthy foods has increased in recent years. These foods include some livestock products with a modified fatty acid composition in fat. Especially the presence of polyenic fatty acids in intramuscular fat has a significant effect on the quality of meat and fat because they have a beneficial effect on human health. It forms an essential component of human food (Wood et al., 2008; Nuernberg et al.,1999). Higher proportion of PUFA may result in undesirable stickiness fat, reducing its strength and oxidative stability. Finally it may result in changes in the organoleptic quality and color products (Wood et al., 2008). A higher PUFA proportion in animal products is, in terms of positive impact on human health, requested (Kouba et al., 2003; Wood et al., 2004; Warnants et al., 1999).

The FA content and their composition in the meat is influenced by many factors, such as nutrition, carcass fatness, sex, age, environment, etc., as De Smet et al. (2004) reported. For important can therefore be some carcass indicators with a direct influence on the FA composition in pig meat.

In this respect, an important role also plays the IMF share of pork, which carries some essential fatty acids and adds a specific taste and juiciness (Ochodnický a Poltársky, 2003).

The IMF proportion in the pork meat has a high heritability (h^2=0.4-0.6). Nevertheless, there are, as well as the FA composition in the backfat, the factors which significantly affect its share. They are the same as mentioned above.

The aim of the study was to evaluate the relationship between selected indicators of the carcass value and intramuscular fat (IMF) content while monitoring the different nutrition effect.

Materials and Methods

Animals

The experiment was carried out at the Testing Station of the Czech University of Life Sciences. 34 total hybrid pigs of the $LW_S x(LW_D xL)$ genotype of balanced sex (barrows/gilts) were fattened. Pigs were penned at an average age of 69 days *p.p.* and at an average live weight (ALW) of 28.7 kg. Their housing and penning was carried out in pairs in accordance to the testing of domestic and foreign programs methodology (Smolák, Ivánek, 1992). After reaching the 115 kg of ALW all animals were slaughtered.

Nutrition and feeding

During the experiment pigs were fed by complete feed mixture (CFM) ad-libitum in several phases with a continuous transition by the feeding curve according to testing methodology. CFMs were composed from the following components: wheat, barley, soybean meal and premix. According to the CFM composition pigs were divided into 3 groups. The first control group (CON), the second with linseed addition (LG) and the third with corn addition (CG). The transitions of CFMs were carried out continuously during the test. CFM nutrient composition is shown Table 1.

Sampling carcas value

The detailed dissection according to Valstra, Merkus (1995) was carried out in slaughtered animals.

The indicators characterizing the carcass quality were observed. These were the lean meat share (LM) respectively backfat thickness (determined by measurin the spot 70 mm from the center of the spinal canal at the level of the second and third penultimate rib by FOM in % respectively in mm), and the main meat parts (MMP) share. Gravimetrically after the extraction with petroleum ether the intramuscular fat content (IMF) in the loin (%) was determined.

The meat samples representing the FA profile in the IMF were collected from the loin (right carcass halve), homogenized and subsequently subjected to chemical analyzes. Fatty acid methyl esters were determined following the total lipids extraction according to Folch et al. (1957). Methanolysis was performed by the cathalytic effect of potassium hydroxide applying and extraction of acids in the form of methyl esters in heptane. The contents of isolated methyl esters were determined using a gas chromatograph (Master GC, Dani Instruments S.p.A., Cologno Monzese, Italy) equipped with a flame ionisation detector and a column with polyethylene glycol as the stationary phase. Helium was used as the carrier gas with a flow rate of 5 ml/min and a split ratio of 1:9.

Statistical analysis

The results were evaluated with the statistical program SAS® Propriety Software Release 6.04 (2001) using analysis of variance (ANOVA) function. The differences between the individual traits were tested *via* a GLM procedure. The results of analysis are presented in tables. Average values of selected parameters of the carcass values were calculated by LS means procedure. The course of dependence between the observed indicators of the carcass values was tested by correlation analysis (Pearson´s correlation matrix).

Table 1. The CFM composition during the test

Nutrition component (%)	ALW fattening periode (kg)								
	25-35			35-65			65-110		
	CON	CG	LG	CON	CG	LG	CON	CG	LG
Wheat	40.00	26.50	28.10	44.55	38.38	30.74	45.34	40.36	31.25
Barley	38.30	30.00	40.00	39.49	32.88	40.00	39.70	33.36	40.00
Corn	-	20.00	-	-	12.80	-	-	11.60	-
Linseed	-	-	15.00	-	-	15.00	-	-	15.00
Soybean meal	18.20	20.00	13.70	12.46	12.80	11.11	11.46	11.60	10.66
Premix	3.50	3.50	3.20	3.50	3.14	3.15	3.50	3.02	3.09

CON = control group, CG = corn addition group, LG = lineseed addition group)

Results

The influence of diet on selected indicators of the carcass value illustrated Table 2. Not significant intergroup differences in the IMF share with regard to the different nutrition have been proven. This concerns also the monitored quantitative parameters of the carcass value, such as LM, backfat thickness as well as MM. Conversely, under the influence of enriched CFMs about corn and linseed, significant changes in FA composition of IMF occurred. Especially the linseed addition diet was the cause of favorable changes in FA composition in pigs.

For the effect of IMF share evaluation the correlation analysis between IMT and selected indicators of the carcass value was performed. The correlation coefficient values and their significance for selected parameters of the carcass value documented Table 3. The results show that the IMF in the test negatively correlated with the LM and MMP share, also with the PUFA content and its family of the PUFA n-6 share. Although the reduced IMF share in the LG group was not shown, the low negative correlation between the IMT and SFA was recorded. In this regard, the positive, moderate to high correlations have been shown for the other groups (CON and CG). In the LG group the correlation between IMT and selected indicators of the carcass values were inconclusive. The exception was the correlation between IMT and PUFA n-6. Correlation between the n-3 PUFA and IMT were also inconclusive. The PUFA:SFA, respectively n-6: n-3 PUFAs shares were, according to the correlation analysis, in the inverse correlation with the IMT share, significantly then in groups CON and CG, respectively in "cumulative-total" group within the n-6:n-3hare.

Discussion

The supplementation of corn respectively flaxseed in the diet was to change the FA composition of the fat in pigs. This does not significantly affect the IMF content. Because different CFMs composition did not affect significantly the IMF share, to evaluate the correlation between the IMF share and selected parameters of the carcass value, the "total group" composed of three nutritionally different groups was compiled. Although the linseed food had the most favorable effect on the carcass quality indicators, especially on the FA composition in the IMT, the inconclusive correlation coefficients between the IMF proportion and quantitative indicators of the carcass value (LM share, back fat, MMP share) were found. The effect of feed components with a higher PUFA proportion dealt Nuernberg et al. (2005). Under the influence of the 5% addition of the linseed or olive oil in the diet they did not record any impact on the carcass characteristics and meat quality. The effect of diet with a higher proportion of unsaturated FA, thanks linseed, also watched Warnants et al., 1999. But those have not shown significant differences in the parameters of carcass value. Huang et al. (2008) demonstrated a higher IMF share with increasing duration of feeding of linseed supplement in the feed mixtures for fattening pigs. This paper also presents an increased LM share in pigs fed with this addition. This is however not confirmed in our case, because the given pig genotype fed of linseed addition, showed less values of this parameter. Han et al. (2005) reported overall less favorable parameters of the carcass value in pigs fed with the corn addition in the diet compared to the control. This fact, our study did not confirm.

Significant according to Hana et al. (2005) is primarily a higher proportion of lean meat in the carcass of pigs fed a corn diet, which was achieved in this experiment, but inconclusively. Significant, according to Han et al. (2005), is primarily a higher LM share in the carcass in pigs fed a corn diet, which was also achieved in this experiment, but insignificantly. For the important findings must be considered the high negative correlation between the n-6 PUFAs and IMT shares in all groups, we tested. The increased IMF share in the carcass means a reduction the n-6 PUFA share in pigs. Analogical correlation described also Cameron, Enser (1991). In their study a higher IMF level was accompanied by a lower level of the main n-6 PUFAs, namely linoleic acid. According to DeSmet et al., (2004), the differences in FA composition can be explained by differences in the LM and fat share in various genotypes in pigs. In our study the differences in FA composition were found without a significant changing the LM and backfat thickness. Also, the PUFA share in the adipose tissue negatively correlated with the fat share in the body in pigs, as documented Kouba et al. (1999), Wood et al. (2008). The same authors also reported by inter breeding differences in the FA share in the fat. Breeds, respectively hybrid pigs with a higher IMF share have a lower PUFA share. Within the "total group" the negative correlation coefficient (r=-0.403) between the PUFA and IMT share was observed, while SFA was positively correlated with the IMF share (r=0.487). This confirms the results of the above authors. An increase PUFA:SFA ratio, which should be, according to medical advice, higher than 0.4, is by Wood et al. (2008) and Kouba et al. (2003) usually achieved by increasing the amount of linoleic acid (n-6), which is accompanied by an undesirable increase in the n-6:n-3 PUFAs ratio of whose recommended value is smaller than 4. Regarding the above two parameters, the addition of linseed showed significantly more favorable of their values. On the other hand, corn supplement caused an inconclusive increasing PUFA:SFA share respectively significant ($P \leq 0.05$) increase the n-6:n3 share. Within the "total group" both ratios (Wood et al., 2008; Kouba et al., 2003) also show the negative values of the correlation coefficient (r=-0.43725, respectively -0.4224, when $P \leq 0, 05$).

Conclusion

The results have shown no effects of the corn and lineseed adition in the diet on the IMF share and quantitative parameters of the carcass value in pigs. The effect of these supplements on quality, respectively the FA composition, however, was demonstrated. In this regard, positive effect of linseed in the pig diet on the FA share in the IMT was confirmed. Significant correlation between the IMF share and monitored carcass parameters were demonstrated. The negative correlation between IMT and LM share and the positive correlation between the IMF share and backfat thickness were shown. Also the negative correlation between IMT and the PUFA was observed. It can be concluded that the more favorable PUFA:SFA share as well as the n-6:n-3 PUFA share in pork meat are accompanied by a simultaneous decrease of the IMT content.

Table 2. The selected carcass value characteristics in pigs

Variable	Group		
	CON (n=10)	CG (n=10)	LG (n=8)
IMT (%)	1.84	1.50	1.83
LM (%)	57.13	57.28	56.26
Backfat (mm)	15.80	15.80	16.88
MMP (%)	52.67	52.67	50.26
SFA*	42.35	41.76	42.64
MUFA*	42.33^{A}	40.96^{B}	35.02^{AB}
PUFA*	15.32^{A}	17.23^{B}	22.35^{AB}
PUFA n-6*	13.89	16.11	14.81
PUFA n-3*	0.87^{A}	0.73^{B}	7.17^{AB}
PUFA:SFA	0.36^{A}	0.42^{b}	0.53^{Ab}
n-6:n-3 PUFA	16.78^{Ac}	22.95^{Bc}	3.60^{AB}

Differences between means marked with the same letters are significant. For $P \leq 0.05$ was used a, b, for $P \leq 0.01$ then A, B.
* Groups of fatty acids are presented in% of total fatty acids

Table 3. Correlation coefficients between the IMF share and selected carcass value characteristics depending on the type of nutrition

Variable	Group			
	Total	CON	CG	LG
	IMT (n=34)	IMT (n=12)	IMT (n=12)	IMT (n=10)
LM (%)	- 0.55095**	- 0.74474*	- 0.69451*	- 0.27884
Backfat (mm)	0.532**	0.80579**	0.67281*	0.15041
MMP (%)	- 0.45778*	- 0.83914**	- 0.45378	- 0.30328
SFA	0.48733**	0.77458**	0.82734**	- 0.25893
MUFA	0.25173	0.7994**	0.62271	0.53283
PUFA	- 0.403*	- 0.8618**	- 0.87639**	- 0.32004
PUFA n-6	- 0.80555**	- 0.87678**	- 0.86149**	- 0.73068*
PUFA n-3	0.20874	- 0.0544	- 0.38485	0.30603
PUFA:SFA	- 0.43725*	- 0.84367**	- 0.88317**	- 0.25957
n6:n3	- 0.4224*	- 0.56262	- 0.42574	- 0.34336

* significance P≤ 0,05 ** significance P≤ 0,01
CON = control group, CG = corn addition group, LG = lineseedd addition group).

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