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FATTENING AND SLAUGHTER PARAMETERS IN THE FIRST PERIOD OF FATTENING OF PIGS FED RESTRICTIVE OR *SEMI AD LIBITUM* DIETS

Justyna Więcek[1], Jacek Skomiał[2], Anna Rekiel[1], Tomasz Florowski[3], Krzysztof Dasiewicz[3], Monika Kosińska[3]

[1]Department of Pig Breeding, Warsaw University of Life Sciences, Warsaw, [2]The Kielanowski Institute of Animal Physiology and Nutrition, Jabłonna, [3]Department of Food Technology; Warsaw University of Life Sciences, Warsaw

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The study carried out on 56 fatteners was aimed at determining the effect of feeding level in the first period of fattening on their growth rate as well as their slaughter value and meat quality. Animals fed restricted amount of feed (-25%), as compared to those fed *semi ad libitum,* were characterised by lower daily body weight gains ($p \leq 0.001$), higher meatiness ($p \leq 0.05$) and more favorable fatty acid profile from the human nutrition point of view. The system of feeding did not have any significant effect on most of the quality attributes of *Musculus longissimus dorsi* (MLD). An increase in body weight of the animals was accompanied by increased mass of loin and ham, back fat thickness and carcass meatiness, whereas a negligible decrease was observed in parameters of meat texture.

INTRODUCTION

Results of investigations carried out so far have pointed out to various possibilities of modifying the quality of pork fat and meat to obtain products of high health-promoting, gustatory and technological values.

The level of feeding affects not only the growth rate of pigs [Gondret & Lebret, 2002; Oksbjerg *et al.,* 2002; Mason *et al.,* 2005], but also the quantity of fat deposited in the gain [Čandek-Potokar *et al.,* 1998; Kristensen *et al.,* 2002], fatty acid profile and flavour of meat [Cameron *et al.,* 2000]. Nonetheless, results published on that issue are not explicit [Čandek-Potokar *et al.,* 1998; Kristensen *et al.,* 2002; Correa *et al.,* 2006].

Along with physical development proceeding, an animal organism displays a tendency for enhanced fat deposition [Gill, 2006]. An increase in fat content of the longissimus muscle results in increasing flavour, tenderness and juiciness of meat [Migdał *et al.,* 2004]. A study by Correa *et al.* [2006] did not demonstrate any significant effect of slaughter weight on free drip and colour of meat. In animals slaughtered at 130 kg b.w. *vs*. 100 kg, Čandek-Potokar *et al.* [1998] observed the MLD to be characterised by a smaller free drip as well as lower tenderness and chewiness.

An increase in the weight of animals at slaughter is additionally accompanied by changes in contents of saturated and unsaturated fatty acids in pork meat [Nürnberg & Wegner, 1991; Walkiewicz *et al.,* 2001; Raj *et al.,* 2005]. In the fatty acid profile of intramuscular lipids of animals with higher body weight, as compared to lighter pigs, Raj *et al.* [2005] observed a lower contribution of polyunsatured fatty acids, whereas Walkiewicz *et al.* [2001] – a higher contribution of PUFA n-6.

The objective of this study was to evaluate the effect of the feeding level of pigs in the first period of fattening on their growth rate, slaughter value and meat quality.

MATERIAL AND METHODS

The experiment was conducted on 56 fatteners (28 barrows and 28 gilts) hybrids of (wbp x pbz) x Duroc. It was commenced at the initial body weight of animals reaching *ca.* 23 kg. Eight fatteners (gilts:barrows, 1:1) were slaughtered at the beginning of the experiment – group 0. The other 48 fatteners were divided analogously into two groups: A and R. In groups A the pigs were fed in a *semi ad libitum* system, whereas in group R – in a restrictive system, *i.e.* at a level of 75% of group A. The animals were fed individually with a feed mixture containing: wheat and barley meal, post-extraction soybean meal, mineral and vitamin additives, crystalline amino acids, linseed oil (4%) and vitamin E. The nutritive value of 1 kg of the mixture reached 13.5 MJ EM and 165 g total protein.

On termination of the first period of fattening, once the animals have reached body weight of *ca.* 62 kg, 8 fatteners (gilts:barrows, 1:1) selected at random from group A and R were slaughtered (a total of 16 animals).

Measurements of pH were carried out according to Polish Standard [PN-77/A-82058] on 24 right half-carcasses using an HI-98240 pH-meter with an FC 231D dagger electrode, in the 45th min and 24th h after the slaughter. After 24-h chilling, the half-carcasses and selected cuts were subjected to measurements and evaluation of meatiness with the total dissection method according to the SKURTCh methodology [Różycki, 1996]. A specimen of the *M. longissimus dorsi*

Author's address for correspondence: Justyna Więcek, Department of Pig Breeding, Warsaw University of Life Sciences, ul. Ciszewskiego 8, 02-786 Warszawa, Poland, tel.: (48 22) 59 365 63; fax (48 22) 853 09 14; e-mail: justyna_wiecek@sggw.pl

(MLD) was excised from the area of the penultimate breast vertebrae in the intracephalic direction. The material was comminuted and determined for chemical composition [AOAC, 1994] and fatty acid profile by means of gas chromatography [ISO 5509:1996; ISO 5508:1996] using a capillary column BXP 70 with the length of 50 m, internal diameter of 0.25 mm and phase thickness of 0.25 μm.

A specimen of MLD was excised from its lumbar area (*m. lumborum*) from 6 animals of each group, *i.e.* 0, A and R (a total of 18 animals). Analyses were carried out for quantities of free drip, thermal drip, absorbed brine [Mroczek, 1997], and water holding capacity of meat [Grau & Hamm, 1952 modified by Pohja & Niinivaara, 1957]. Colour of meat was measured with a Minolta CR-200 colorimeter and texture – using a ZWICKI testing machine type 1120.

Results obtained were elaborated statistically by means of one-way analysis of variance using the method of the least squares, with consideration given to effects of the feeding level [SPSS, 2000]. In analysing results of quantitative slaughter traits, slaughter weight of a fattener was considered as a co-variable. Results of slaughter traits of animals with body weight of *ca*. 23 kg were presented as arithmetic means.

RESULTS

Body weight gains of the animals fed in the *semi ad libitum* system (group A) reached 806 g and were higher by 238 g than those of pigs fed restrictive diets (group R), (Table 1). In respect of carcasses of animals from group A, the carcasses of fatteners from group R were characterised by great loin eye area (by 4.1 cm^2), lower adiposity of loin cut ($p \leq 0.01$) and higher meatiness (by 1.7%). The animals slaughtered at the beginning of the study, compared to those with body weight of 62 kg (irrespective of the feeding level) displayed lower dressing percentage, lower back fat thickness, higher bone content, as well as lower meat and fat contents of loin and ham.

Contents of dry matter and total fat in MLD of animals from group 0 were higher than those reported in fatteners from group A and R (Table 2). In turn, contents of dry matter and total protein in MLD of animals from groups A and R were alike. In pigs fed the restrictive diet the content of crude fat was lower by 0.4 percentage points (difference not significant statistically).

No statistically significant differences were reported between groups A and R in such qualitative parameters of MLD as: free drip, thermal drip and water holding capacity (Table 2). In contrast, a higher percentage ($p \leq 0.01$) of absorbed brine was observed in the group fed in the *semi ad libitum* system. Despite a lack of significant differences, a slightly brighter colour (L) of the muscle was observed in group R that was additionally characterised by higher shear force, chewiness and hardness as compared to the muscle from group A. In comparing the qualitative parameters of MDL of pigs slaughtered at body weight of 23 kg *vs*. 62 kg, increased values were observed for: percentage of thermal drip determined in comminuted material, percentage of absorbed brine, a* – colour parameter in a Hunter scale, springiness and cohesiveness. The other parameters were subject to a decrease.

The MLD lipid fraction of animals from group R, in contrast to those of group A, was found to contain less SFA and MUFA as well as more PUFA n-6 ($p \leq 0.05$) and PUFA n-3 (Table 3). The MLD lipid fraction of animals from group 0, as compared to fatteners from groups A and R, was characterised by a smaller contribution of SFA and PUFA n-3 and a higher percentage of PUFA n-6.

TABLE 1. Daily body weight gains and results of slaughter performance of the fatteners.

Specification	Group 0	Group		Effect of feeding level	
		A	R	SE	p*
Daily body weight gain (g)	-	806	568	12.753	0.001
Slaughter weight (kg)	23.1	62.8	61.1	0.564	NS
Cold half-carcass weight(kg)	7.7	23.1	23.7	0.131	0.042
Dressing percentage (%)	66.5	74.6	76.6	0.428	0.047
Half-carcass length (cm)	49.5	66.3	64.7	0.361	NS
Mean back fat thickness (mm)	7.0	14.7	13.7	0.407	NS
Loin eye area (cm^2)	12.0	26.1	30.2	0.718	0.021
Loin (kg)	1.2	3.9	4.0	0.074	NS
Loin meat (%)	50.8	57.7	61.2	0.566	0.038
Loin fat (%)	10.9	17.3	13.0	0.549	0.003
Loin bones (%)	29.6	18.7	19.0	0.317	NS
Ham (kg)	1.6	5.0	5.4	0.042	0.001
Ham meat (%)	68.4	73.5	74.9	0.393	NS
Ham fat (%)	8.5	10.6	10.2	0.349	NS
Ham bones (%)	15.8	10.5	9.7	0.165	0.034
Carcass meatiness (%)	46.6	54.3	56.0	0.346	0.038

*NS - $p > 0.05$

TABLE 2. Chemical composition and quality of *Musculus longissimus dorsi*.

Specification	Group 0	Group		Effect of feeding level	
		A	R	SE	p*
Dry matter (%)	25.4	24.3	24.2	0.101	NS
Total protein (%)	20.6	21.9	21.7	0.141	NS
Crude fat (%)	1.7	1.5	1.1	0.101	NS
pH 45'	6.34	6.28	6.12	0.067	NS
pH 24 h	5.85	5.71	5.59	0.025	0.043
Free drip (%)	0.48	3.25	3.22	0.263	NS
Water holding capacity (cm^2/g)	18.88	26.02	26.45	0.820	NS
Thermal drip (%) in:					
cut	24.05	29.03	28.20	0.382	NS
comminuted meat	10.10	3.89	3.05	0.568	NS
Absorbed brine (%)	6.83	5.58	3.03	0.320	0.003
Colour:					
L	50.03	55.66	56.68	1.377	NS
a*	10.12	8.02	8.55	0.397	NS
b*	0.13	0.64	1.37	0.438	NS
Shear force (N)	54.15	89.17	93.35	5.265	NS
Penetration force (N)	32.07	41.35	38.73	1.707	NS
Springiness	0.63	0.58	0.58	0.017	NS
Cohesiveness	0.53	0.52	0.50	0.008	NS
Chewiness (N)	15.50	19.05	20.67	0.927	NS
Hardness (N)	46.38	69.27	73.22	3.016	NS

*NS - p>0.05

TABLE 3. Fatty acid profile of *Musculus longissimus dorsi* (%).

Specification	Group 0	Group		Effect of feeding level	
		A	R	SE	p*
SFA	40.69	41.49	40.90	0.285	NS
C 14:0	1.58	1.41	1.38	0.019	NS
C 16:0	26.75	25.42	25.05	0.127	NS
C 18:0	12.36	14.66	14.47	0.202	NS
MUFA	45.07	45.54	44.12	0.496	NS
C 16:1	4.44	2.84	2.84	0.063	NS
C 18:1	40.63	42.69	41.28	0.447	NS
PUFA n-6	13.35	8.74	10.45	0.343	0.026
C 18:2	12.16	7.94	9.35	0.301	0.034
C 20:4	0.94	0.67	0.93	0.051	0.020
C 22:4	0.25	0.14	0.16	0.012	NS
PUFA n-3	0.90	4.24	4.54	0.195	NS
C 18:3	0.63	3.59	3.68	0.152	NS
C 20:5	0.07	0.27	0.38	0.026	NS
C 22:5	0.13	0.32	0.40	0.032	NS
C 22:6	0.06	0.06	0.08	0.006	NS
PUFA n-6/n-3	14.89	2.09	2.31	0.055	NS
PUFA/SFA	0.35	0.31	0.37	0.014	NS

*NS - p>0.05

DISCUSSION

The growth rate of animals fed 25% reduced feed mixtures was *ca*. 30% lower than that of pigs fed in the *semi ad libitum* system. Also in experiments carried out by Čandek-Potokar *et al.* [1998] and Gondret & Lebret [2002] reducing a daily dose of feed mixture by 25-30% caused a decrease in daily body gains of fatteners by *ca*. 25%.

Likewise in the study by Wagner *et al*. [1999], an increase in body weight of slaughtered pigs was accompanied by an increase in dressing percentage, back fat thickness carcass length, mass of loin and ham as wells their adiposity. The content of dry matter in MLD of animals with body weight of 23 kg was higher and that of total protein – lower, as compared to the respective parameters determined in groups of animals with body weight of 62 kg. Gill [2006] demonstrated a lower (by 1%) content of water and protein in carcasses of lighter gilts (30 kg *vs.* 50 kg). In the reported study, the content of crude fat in MLD of animals from group 0 was higher than that of animals slaughtered at the end of the first period of fattening, irrespective of the feeding system. Before commencing the experiment, the gilts were fed *ad libitum.* This could be the reason of an increased fat content of MLD in the lighter animals, when compared to the heavier pigs finishing the I period of fattening. In a study carried out on fatteners. Bartkowiak [2003] demonstrated a higher content of intramuscular fat in animals fed *ad libitum* than in those fed in a dosed or restrictive system.

Carcasses of animals fed *semi ad libitum vs.* those of pigs fed with the restrictive diet were characterised by a higher total adiposity and higher percentage of intramuscular MLD fat. A review by Skiba [2005] indicates that feeding restrictions, consisting in reducing the content of protein in a feed mixture, lead to increasing adiposity of carcasses, and that a reduced dose of the mixture causes lower fat deposition. Nutrients absorbed with feed are utilized by animals first for maintenance, deposition of protein, and then for deposition of fat. Thus, pigs fed a restricted diet are characterised by lower adiposity [Čandek-Potokar *et al.,* 1998; Gondret & Lebret, 2002; Kristensen *et al.,* 2002; Oksbjerg *et al.,* 2002; Mason *et al.,* 2005]. In experiments of a number of authors [Čandek-Potokar *et al.,* 1998; Gondret & Lebret, 2002; Kristensen *et al.,* 2002; Mason *et al.,* 2005], the smaller total adiposity was accompanied by a lower content of intramuscular fat (IMF). As reported by Daszkiewicz *et al.* [2005], IMF content exceeding 3% improves flavour, juiciness and tenderness of pork meat. As compared to meat of animals fed *ad libitum*, the meat originating from animals fed in the restrictive system and containing less IMF was characterised by negligibly worse taste [Cameron *et al.,* 2000], as well as lower tenderness and juiciness [Bartkowiak, 2003]. Deterioration of taste attributes could have resulted from an increased contribution of polyunsaturated acids in neutral lipids [Cameron *et al.,* 2000]. Increasing concentrations of PUFA, especially of n-3 acids, although desired from the health-promoting viewpoint, may lead to deterioration of taste attributes of meat [Łyczyński *et al.,* 2003]. Usually, it results from the addition of vegetable and fish oils to feed mixtures [Raes *et al.,* 2004; Wood *et al.,* 2003]. The capability of unsaturated fatty acids for rapid

oxidation, especially in the case of those with more than two double bonds, is likely to affect color and hardness of meat [Wood *et al.,* 2003]. Undesirable taste of meat during culinary processing, resulting from lipid oxidation, may be perceptible when over 3% of linoleic acid are detected in the fatty acid composition [Shackelford *et al.,* 1990].

A change in the fatty acid profile of animal tissues proceeds not only upon the effect of feed additives but is also determined by the feeding system. As reported by Raclot & Oudart [2000], malnutrition-induced mobilization of fatty acids from storage tissues may lead to changes in their fatty acid profile.

The increase in body weight was accompanied by a greater contribution of saturated fatty acids in the lipid profile of intramuscular fat, which was consistent with results reported by Walkiewicz *et al.* [2001]. In determining contents of selected fatty acids in back fat of young boars slaughter at body weight of 21.4 kg and 76.6 kg, Nürnberg & Wegner [1991] demonstrated a higher contribution of C16:0, C18:0 and C18:1 acids and a lower contribution of C14:0 and C16:1 acids in the heavier animals. Similar dependencies were observed in our study; what is more the lighter animals were characterised by a greater contribution of PUFA n-6 acids. In experiments conducted by Walkiewicz *et al.* [2001], an increase in slaughter weight was accompanied by an increasing content of PUFA n-6 acids, a decreasing contribution of PUFA n-3 acids and increasing ratios of PUFA n-6/n-3 in the intramuscular lipid profile. However, the effect of body weight on fatty acids profile cannot be determined explicitly based on the results obtained. In the reported study, the feed mixture contained 4% of linseed oil, which affect the fatty acid profile and the PUFA n-6/n-3 ratio in MLD of the animals with body weight of 62 kg, irrespective of the feeding group. In groups A and R, the PUFA n-6/n-3 ratio reached 2:1. It should be considered dietetically-favourable since, as reported by Raes *et al.* [2004], the n-6/n-3 ratio should account for <5. The 4% addition of linseed oil to the feed mixture in the II fattening period has been reported to increase the contribution of PUFA n-3 acids in the lipid profile of *M. longissimus dorsi* and *M. semimembranosus* as well as to diminish ratios of PUFA n-6/n-3 from 10 to *ca*. 2.5 [Więcek & Skomiał, 2004].

Likewise in a study by Mason *et al.* [2005], a higher contribution of polyunsaturated fatty acids was observed in the fatty acid profile of MLD of animals fed restrictive *vs*. *semi ad libitum* diets. The differences were not distinct and did not affect deterioration of MLD quality. The lack of differences between the group could have resulted from a generally low content of crude fat in MLD. Out of all meat breeds, the Duroc breed is characterised by the highest content of intramuscular fat (IMF) [Łyczyński *et al.,* 2003; Mason *et al.,* 2005]. In the reported study, despite 50% share of Duroc breed in the genotype of fatteners, the content of IMF was low and did not exceed 1.5%.

More favourable quality traits of MLD expressed by a higher water absorption, smaller exudation of juice from cells of muscle tissue and texture parameters, *i.e.* lower shear and penetration force, chewiness and hardness, were observed in the animals with slaughter weight of 23 kg. The analysis of the results obtained and their comparison with literature data are difficult since, usually, experiments are conducted on animals with a higher slaughter weight. Investigations carried out by Fischer *et al.* [2006] on heavy fatteners demonstrated that increasing the slaughter weight from 110 kg to 153 or 160 kg elicited a slight increase in exudate from muscle tissues and a greater muscle saturation with red colour.

As reported by Wood *et al.* [2003], fatty acid composition determined the technological quality of meat due to a different melting point of individual acids. Texture evaluation of MLD originating from the animals of group R demonstrated greater chewiness and hardness of the muscle as well as lower quantity of brine absorbed, as compared to fatteners of group A. In both feeding groups, free drip was at a comparable level, likewise in the study by Oksbjerg *et al.* [2002]. Those results are, however, inconsistent with findings of other authors. In animals fed restrictive *vs*. *ad libitum* diet, Kristensen *et al.* [2002] demonstrated a smaller free drip, whereas opposite dependencies may be observed in a work by Čandek-Potokar *et al.* [1998]. Those differences may result from diet composition and dosage as well as from the length of the restrictive feeding period.

CONCLUSIONS

Based on the conducted experiment, aimed at evaluating the system of feeding of pigs in the first fattening period on their fattening and slaughter parameters, it may be concluded that the animals fed a restrictive diet, compared to those fed *semi ad libitum*, are characterized by a lower growth rate, higher meatiness and more favourable – from the human nutrition point of view – profile of fatty acids. The level of feeding appeared not to exert any significant effect on meat quality. An increase in body weight of the fatteners was accompanied by increasing weights of loin and ham, back fat thickness and carcass meatiness, and by slightly diminished parameters of meat texture.

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