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Full Length Research Paper

The effect of sex, slaughter weight and weight gains in PEN-AR-LAN fatteners on their slaughter value

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The aim of the study was to determine the effect of sex, body weight and growth rates on basic fattening and slaughter indexes in PEN-AR-LAN fatteners. The research was conducted on 274 PEN-AR-LAN hybrid fatteners coming from sows of the Naïma maternal line and was sired by boars of the P-76 meat line. Recorded fattening and slaughter performance values indicated that PEN-AR-LAN hybrid pigs could be good material for the production of fatteners. The highly significant effect of sex on back fat thickness and meat content and significant effect on the loin eye area were shown. Gilts were characterized by higher meatiness (56.2 vs. 53.4%) and lower back fat thickness (16.4 vs. 20.3 mm) than castrated males. Fatteners with lower slaughter weight were characterized by thinner backfat and smaller height of the loin 'eye'. No significant effect of the slaughter weight on the meat content in the carcass was found. Fatteners with daily weight gains below 700 g had the thinner backfat amounting to 16.7 mm (at P ≤ 0.01) in comparison with 19.6 and 19.5 mm for animals with higher weight gains. Animals with lower weight gains had the higher meatiness (55.7%, at P ≤ 0.01) in comparison with animals of higher weight gains (54.2 and 53.7%).

Key words: Pigs, PEN-AR-LAN, slaughter value, sex, slaughter weight, daily gain.

INTRODUCTION

The rapid growth of the worldwide population has resulted in necessity of increasing the food production. In this way, the primary aim of breeding work has become enhancing the animal productivity. The increase of the pork production and consumption in the European Union was positively influenced by implementation of objective classification methods of porcine carcasses in the 1980's (Vítek et al., 2008). In Poland also, since the introduction of the instrumental carcass classification, a considerable progress was obtained in improvement of meatiness in the mass population (Strzelecki et al., 2008). Unfortunately, it was frequently achieved at expense of the weight reduction in fatteners (Grześkowiak et al., 2005). It is the negative phenomenon as such practices decrease the yield of prime cuts and total meat yield and were also difficult for carcasses to obtain the desirable weight at considerable meat content (Strzelecki et al., 2008).

Breeds and pig lines differ in terms of economically important traits, such as leanness, fatness and reproduction performance (Tyra and Żak, 2010; Szyndler-Nędza et al., 2010). It has reflected on/ upon differentiation of the time when they reach the maximum meat content in the carcass. For pure breeds, studies on optimal slaughter weight are conducted relatively extensively. However, with introduction of the economical market in Poland in 1989, hybrid pigs have started gaining significant importance. The most popular animals, next to those from native line 990, included pigs offered by PIC, Hypor and PEN-AR-LAN. The FrenchCompany PEN-AR-LAN recommends animals coming from mating of Naïma sows with boars from line P-76. As indicated by Rybarczyk et al. (2004), these fatteners are characterized by high meatiness and good meat quality. However, the sex effect, body weight and weight gains on their

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Table 1. Chemical composition of the feed mixtures.

Item	Feed mixture	
	First period (30 to 70 kg body weight)	Second period (after 70 kg body weight)
Energy (MJ/kg)	12.2	12.3
Crude protein (g/kg)	171	158
Digestible protein (g/kg)	139	127
Lysine (g/kg)	9.95	8.27
Met + Cys (g/kg)	6.13	5.79

slaughter value in these fatteners has not been investigated thoroughly. Hence, the aim of this study was to determine the sex effect, body weight and growth rates on basic fattening and slaughter indexes in PEN-AR-LAN fatteners.

MATERIAL AND METHODS

The research was conducted on 274 PEN-AR-LAN hybrid fatteners coming from sows of the Naïma maternal line and was sired by boars of the P-76 meat line. Fatteners were kept in collective fattening pens on deep litter with feeding system *ad libitum*. The chemical composition of feed mixtures is shown in Table 1. Feeding and zoohygienic management conditions were identical for all groups of animals and were according to breeding and production standards. Animals were weighed twice: at beginning of fattening and on the slaughter day. Animals were slaughtered in the slaughterhouse according to the following conditions: rest time - two hours of pre-slaughter, automatic electric stunning and exsanguinations in the horizontal position, carcasses were chilled in the fast cooling system. The backfat thickness and loin thickness were determined using the CGM apparatus by Sydler (France) and on this base; the meat content in carcasses were calculated.

In conducting experimental analyses, the following data were collected: age and body weight on the first day of fattening and on the slaughter day, carcass weight, dressing percentage, backfat thickness and height of the loin 'eye' and also meat content. The animal material was divided into groups according to the following criterions:

(1) Sex: castrated on the 7th day of age using the surgical method boar piglets (n = 161) and gilts (n = 113),
(2) Slaughter weight: fatteners with slaughter weight below 110 kg (n = 38), 111 to 120 kg (n = 88), 120 to 130 kg (n = 97) and fatteners above 130 kg (n = 56),
(3) Daily weight gains: fatteners with daily weight gains below 700 g (n = 83), 700 - 800 g (n = 116) and above 800 g (n = 75).

Statistical analysis

In order of verifying statistical differences caused by sex, slaughter weight and weight gains, the multivariate analysis of covariance was conducted for slaughter traits, taking into consideration partial regression coefficients (first-order) in terms of age and body weight at weaning according to the following model:

$$y_{ijkl} = \mu + p_i + l_j + m_k + d_l + b_1 w (o)^1_{ijkl} + b_2 m (o)^1_{ijkl} + e_{ijkl}$$

Where, y_{ijkl} is the trait value of the ijkl-th animal; μ is the overall mean; p_i is the fixed effect of the i-th sex; l_j is the fixed effect of the j-th sow; m_k is the fixed effect of the k-th slaughter weight, (j = 1, 2, …4); d_l is the fixed effect of the l-th daily weight gains; b_1 is the partial regression coefficient (first order) of age on the first day of fattening for given trait; $w (o)^1_{ijkl}$ is the age on the first day of fattening for ijkl-th animal; b_2 is the partial regression coefficient (first-order) of the body weight on the first day of fattening for the given trait; $m (o)^1_{ijkl}$ is the body weight on the first day of fattening of the ijkl-th animal; e_{ijkl} is the random error connected to the ijkl-th animal. Statistical calculations were performed using SAS 9.1. statistical package (2009).

RESULTS AND DISCUSSION

Table 2 presents the general characteristic of selected slaughter traits of PEN-AR-LAN fatteners. The analysed population of fatteners was characterized by high slaughter weight amounting to the mean of 122.2 kg. The mean meat content in analysed animals was 54.5%, ranging from 44.5 to 63.8%. More also, the backfat thickness was 18.7 mm at mean height of the loin 'eye' amounting 59.5 mm.

The sex effect on fluctuations in slaughter traits is presented in Table 3. It was observed that castrated males were characterized by lower age at slaughter (183 days, at $P \leq 0.05$) than gilts. Statistically significant differences (at $P \leq 0.01$) between sexes were also recorded for backfat thickness, height of the loin 'eye' and meat content. For these traits, more profitable results were shown in gilts. As was expected, females had the thinner backfat (16.5 vs. 20.3 mm) than castrates, while gilts had the higher loin 'eye' (60.5 vs. 58.7 mm) and higher meat content (56.2 vs. 53.3%).

Furthermore, results of evaluation of fattening and the slaughter value of PEN-AR-LAN fatteners according to the slaughter weight are presented in Table 4. The analysed population was divided into 4 groups according to the slaughter weight of animals. The statistical analysis showed that animals from groups with lower slaughter weights (<110 kg and 111 to 120 kg) were characterized by statistically significant thinner backfat (15.7 and 17.3 mm, $P \leq 0.01$) in comparison with the group of animals with higher slaughter weight (19.6 mm for animals weighing 121 to 130 kg and 20.9 mm in animals weighing more than 130 kg). Recorded differences were highly statistically significant.

The height of the loin 'eye' recorded in the group of animals with slaughter weight up to 120 kg was lower than in heavier fatteners (121 to 130 kg and >130 kg).

Table 2. General characteristics of selected fattening and slaughter traits of PEN-AR-LAN fatteners.

Traits (n = 274)	$\bar{x}$	Minimum	Maximum	SD	CV
Body weight at beginning of fattening (kg)	9.3	3.30	18.4	2.78	30.1
Age at beginning of fattening (days)	33.2	18.0	51.0	9.57	28.9
Body weight at slaughter (kg)	122	100	148	9.95	8.14
Age at slaughter (days)	186	141	290	20.0	10.8
Daily weight gain during fattening (g)	750	456	1168	94.88	12.66
Lifetime daily weight gain (g)	662	432	844	69.00	10.42
Carcass weight (kg)	95.1	75.4	116	8.34	8.77
Dressing percentage (%)	77.8	65.7	86.5	2.06	2.65
Backfat thickness (mm)	18.7	8.00	35.0	4.78	25.6
Height of the loin 'eye' (mm)	59.5	39.0	83.0	7.10	11.9
Meat content (%)	54.5	44.5	63.8	3.70	6.79

Table 3. Results of evaluation of the slaughter value of PEN-AR-LAN fatteners according to the sex.

Trait	Sex					
	Castrated males (n = 161)			Gilts (n = 113)		
	$\bar{x}$	SD	CV	$\bar{x}$	SD	CV
Body weight at beginning of fattening (kg)	9.25	2.81	30.3	9.27	2.7	29.9
Age at beginning of fattening (days)	33.5	9.46	28.3	32.7	9.75	29.8
Body weight at slaughter (kg)	123	9.70	7.85	120	10.0	8.34
Age at slaughter (days)	183^{a}	18.1	9.88	189^{b}	21.9	11.6
Daily weight gain during fattening (g)	771^{A}	85.85	11.14	719^{B}	99.27	13.80
Lifetime daily weight gain (g)	678^{A}	64.20	9.47	639^{B}	69.54	10.87
Carcass weight (kg)	95.9	8.20	8.55	93.9	8.42	8.97
Dressing percentage (%)	77.6	1.68	2.16	78.0	2.49	3.19
Backfat thickness (mm)	20.3^{A}	4.63	22.8	16.4^{B}	4.02	24.5
Height of the loin eye (mm)	58.7^{a}	6.84	11.6	60.5^{b}	7.36	12.2
Meat content (%)	53.4^{A}	3.45	6.47	56.2^{B}	3.39	6.04

a, b - Values in rows with different letters differ significantly (P≤0.05); A, B - values in rows with different letters differ significantly (P≤0.01).

The mean value of this trait in groups with lower slaughter weights (<110 kg and 110 to 120 kg) differed statistically (P ≤ 0.01) from other two groups. Also, the meat content observed in all the groups was similar and the mean value ranged from 55.0% for group with lowest slaughter value (<110 kg) to 54.2% for animals from group with highest slaughter value (>130 kg). However, these differences were not statistically significant.

In addition, Table 5 lists results of the slaughter value testing in PEN-AR-LAN fatteners depending on the level of daily weight gains during fattening. Statistically highly significant differences were observed between all groups according to the body weight and slaughter age. The lowest body weight of 118 kg at highest age at slaughter amounting 202 days was recorded for group of pigs, when the daily weight gain was lower than 700 g. The highest slaughter weight (125 kg) and lowest age at slaughter (171 days) were found for group with highest daily weight gains (>800 g). Animals from group of weight gains below 700 g were characterised by the lightest carcasses. According to values for monitored trait, this group differed statistically (p ≤ 0.01) from other groups. Moreover, the lowest dressing percentage (77.3%, P ≤ 0.01) and thinnest backfat (16.7 mm, P ≤ 0.01) as well as the highest leanness (55.7%, P ≤ 0.01) recorded for this group in comparison to animals from other groups of daily weight gains.

Specific conditions for Polish pig production and breeding sector such as fragmentation and low specialisation of production result in the Polish White landrace and Large White Polish breeds comprising the majority of the pig population. As reported by Tyra and Zak (2010) during the period of 2007 to 2009 at Pig Slaughter Testing Stations, a total of 4430 gilts were tested among which the biggest number represented the Polish White landrace breed (2083 head) and Large White Polish pigs (1240 head). However, next to native maternal breeds (PWL and LWP) and paternal breeds (Pietrain, Hampshire, Duroc) and their crosses, hybrid pigs are being used in fattening with increasing frequency.

Table 4. Results of evaluation of the slaughter value of PEN-AR-LAN fatteners according to the slaughter weight.

Trait	Slaughter weight											
	<110 kg (n = 33)			111 to 120 kg (n = 88)			121 to 130 kg (n = 97)			>130 kg (n = 56)		
	$\bar{x}$	SD	CV	$\bar{x}$	SD	CV	$\bar{x}$	SD	CV	$\bar{x}$	SD	CV
Body weight at beginning of fattening (kg)	9.36	3.01	32.1	9.17	2.99	32.7	9.35	2.92	31.3	9.15	2.01	21.9
Age at beginning of fattening (days)	34.7	8.95	25.8	34.4	10.2	29.7	32.3	9.91	30.7	31.8	8.09	25.5
Body weight at slaughter (kg)	105^{A}	3.34	3.17	115^{B}	2.84	2.46	126^{C}	2.75	2.19	135^{D}	4.38	3.23
Age at slaughter (days)	177^{A}	22.2	12.5	179^{A}	18.4	10.3	188^{B}	21.0	11.1	197^{C}	12.0	6.07
Daily weight gain during fattening (g)	692^{A}	115.66	16.72	750^{B}	105.48	14.06	758^{B}	90.17	11.90	768^{B}	51.41	6.69
Lifetime daily weight gain (g)	603^{A}	74.89	12.42	653^{B}	66.04	10.12	675^{BC}	67.27	9.97	691^{C}	47.10	6.82
Carcass weight (kg)	82.2^{A}	3.66	4.46	89.8^{B}	3.04	3.39	97.8^{C}	3.34	3.42	106^{D}	4.22	3.97
Dressing percentage (%)	77.9	2.16	2.77	77.4^{a}	2.01	2.60	77.7	2.03	2.61	78.3^{b}	2.04	2.61
Backfat thickness (mm)	15.7^{Aa}	3.67	23.5	17.4^{Ab}	4.33	25.0	19.6^{Bc}	4.54	23.2	20.9^{Bc}	4.99	23.9
Height of the loin eye (mm)	55.0^{Aa}	5.41	9.84	57.6^{Ab}	7.18	12.5	60.9^{Bc}	6.41	10.6	62.6^{Bc}	6.96	11.1
Meat content (%)	55.0	3.00	5.43	54.9	3.81	6.95	54.2	3.72	6.86	54.2	3.87	7.15

a, b, c - Values in rows with different letters differ significantly (P≤0.05); A, B, C - values in rows with different letters differ significantly (P≤0.01)

Table 5. Results of evaluation of slaughter value of PEN-AR-LAN fatteners depending on daily weight gains during fattening.

Trait	Daily weight gains during fattening								
	<700 g (n = 83)			700 to 800 g (n = 116)			> 800 g (n = 75)		
	$\bar{x}$	SD	CV	$\bar{x}$	SD	CV	$\bar{x}$	SD	CV
Body weight at beginning of fattening (kg)	8.02	2.13	26.6	9.08	2.74	30.2	10.9	2.72	25.0
Age at beginning of fattening (days)	31.7	8.33	26.3	31.3	9.26	31.3	37.7	9.94	26.4
Body weight at slaughter (kg)	117^{A}	8.89	7.54	123^{B}	9.41	7.63	125^{C}	10.5	8.35
Age at slaughter (days)	202^{A}	18.0	8.91	184^{B}	15.1	8.19	171^{C}	15.4	9.03
Carcass weight (kg)	91.3^{A}	7.57	8.29	96.4^{B}	7.71	8.00	97.2^{B}	8.74	9.02
Dressing percentage (%)	77.3^{A}	2.43	3.15	78.1^{B}	1.74	2.23	77.7^{A}	1.97	2.54
Backfat thickness (mm)	16.7^{A}	4.88	29.2	19.6^{B}	4.97	25.5	19.5^{B}	3.64	18.7
Height of the loin eye (mm)	59.6	6.90	11.6	60.1	7.09	11.8	58.4	7.28	12.5
Meat content (%)	55.7^{A}	3.76	6.76	54.2^{B}	3.98	7.35	53.7^{B}	2.80	5.21

a, b, c - Values in rows with different letters differ significantly (P≤0.05); A, B, C - values in rows with different letters differ significantly (P≤0.01).

In Poland, pigs of the line 990 are popular hybrid pigs and in testing stations, they rank on the third position with number 608 gilts being tested (Tyra and Żak, 2010). Moreover, considerable interest is also observed in PEN-AR-LAN hybrid animals coming from mating of sows from the Naïma maternal line with boars of the highly producing meat line P-76. The primary aim of commercial crossing is to produce crosses showing the good fattening and slaughter value. Effects of the crossing result from pattern of biochemical and physiological traits changed in crosses in comparison with animals of pure breeds (Różycki, 2004). Results of numerous studies indicate that as a rule, crossbred animals are characterised by their enhanced growth rate and leanness than pure breeds and animals coming from different crossing variants differ in fattening and slaughter value (Buczyński et al., 2005; Szulc et al., 2006; Tyra and Żak, 2010).

The population analysed in this study at mean body weight of 122 kg characterised the backfat thickness of approximately 18 mm and meat content of 54%. In case of the backfat thickness, this result was lower than in PEN-AR-LAN pigs tested in 2007/ 2008 (Bahelka et al., 2007; Strzelecki et al., 2008). The mean backfat thickness analysed by Strzelecki et al. (2008) in fatteners of different weight ranges (103, 113 and 133 kg) was higher than the value of this trait in respective of weight ranges for animals in this study, amounting to 19.6, 22.6 and 23.2 mm. Lebret et al. (2006) while reporting the crossbred of the synthetic line at lower slaughter weight

amounting 109.6kg, stated that the backfat thickness on the similar level as indicated from our result (18.5 mm). When analysing the level of the meat content in the carcass in this population, it was found that this result was similar to those reported by other authors. For example, Grześkowiak et al. (2003) while reporting on PEN-AR-LAN fatteners found that the meat content ranged from 54.8 to 55.2%. Strzelecki et al. (2008) recorded meatiness ranging from 54.9 to 55.6% depending on the slaughter weight. The meat content also recorded by Czyżak-Runowska et al. (2006) for pigs of the hybrid line 990 was similar to that recorded in this study (54.1%). The higher level of the meat content was found by Koczanowski et al. (2006) with value of this parameter observed for native population of fatteners examined by those researchers amounting to 56.8%. In turn, the mean meatiness determined by Tyra and Żak (2010) for gilts of the line 990 was higher and amounted to 59.8%. Moreover, Kawęcka et al. (2009) recorded higher meat content for gilts of the line 990 (58.7%), and Lebred et al. (2006) for crossbred synthetic line obtained meatiness on the similar level as obtained from our result (53.4%). The little different observation was reported for other hybrid pigs by Moore et al. (2007). Results found in this study therefore suggested that PEN-AR-LAN hybrid pigs can constitute the good material for the production of fatteners. However, their performance particularly in relation to meatiness is comparable or lower in relation both to native fatteners and animals from line 990.

The sex is one of the factors affecting fattening and the slaughter value in pigs. When analysing the backfat thickness, it can be observed that castrated males had the thicker backfat than gilts ($P \leq 0.01$). According to the results of Hamilton et al. (2000), Pietrese et al. (2000), Latorre et al. (2004), Ranadeau and Mourot(2007) and Lammers et al. (2008), carcasses from barrows were fatter than those from gilts. Similar results were reported by Bahelka et al. (2007), who in their study recorded a backfat thickness of 29.0 mm for barrows and 25.6 mm for gilts. The differences observed in the aforementioned authors between sexes were also statistically significant. The analysed meat content of PEN-AR-LAN gilts was higher than for castrates. The mean meat content of these gilts was 56.2%, while for castrated males it amounted to 53.4%. Bahelka et al. (2007) also stated for gilts, a statistically highly significantly higher meatiness than for barrows. Studies conducted by many authors indicate, that the meat content decreases with the increase of the slaughter weight (Latorre et al., 2004; Barowicz et al., 2006; Bahelka et al., 2007; Strzelecki et al., 2008).

On the other hand, the considerable differentiation is observed among breeds respectively. High meat-producing breeds typically are less likely to reduce leanness at increase in the slaughter weight than native breeds (Zlotnicka White, Zlotnicka Spotted). This statement was also confirmed in this study. The significantly ($p \leq 0.01$) thicker backfat was found in groups with higher body weight (120 to 130 kg and >130 kg) compared with groups of the lower body weight (<110 kg, 111 to 120 kg). A similar observation was reported by Pietrese et al. (2000) on modern pig hybrids with different weights. It was shown that the increase of the slaughter weight had no significant effect on the reduction of the meat content in the carcass. Similar results for meat content in PEN-AR-LAN fatteners were also reported by Strzelecki et al. (2008). Heavy fatteners with mean weight of 133 kg analysed by those authors reached meatiness of 54.9%, while light fatteners with body weight of 103 kg characterized meatiness amounting 55.6%. Differences between those animals were not statistically significant. Both in this study and in the study by Strzelecki et al. (2008), increase of the dressing percentage with increase of the slaughter weight was observed. In this way, it can be assumed that the slight reduction of the meat content with increasing slaughter weight should not have the negative effect on economic results of the production in case of these animals. In addition, when analysing the effect of the growth rate on fluctuations of slaughter traits, it was found that the group with lowest weight gains characterised the thinnest backfat and highest meat content in comparison with groups of higher weight gains. These results are consistent with the study by Żak et al. (2009).

Conclusion

Summing up the recorded results, it should be stated that the effect of individual factors on fluctuations of the slaughter value of carcasses varied in PEN-AR-LAN fatteners. A highly significant effect of sex on the backfat thickness and leanness as well as the significant effect on the height of the loin ‘eye’ were found. It was also observed that the increase of weight gains of more than 700 g had a significant effect on the increase of fatness and reduction of the meat content in carcasses of these animals. The primary result of conducted investigations being the high practical value is the fact that the increase of the slaughter weight in PEN-AR-LAN fatteners did not significantly affect the meat content level in produced carcasses.

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