Effect of feed additives on the results of fattening and selected slaughter and quality traits of pork meat of pigs with different genotypes

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ABSTRACT: The effect of feed additives: antibiotic (group C), probiotic (group E1) and prebiotic (group E2) on the results of fattening and selected slaughter and pork meat quality traits of two genotypes of pigs (PLW × PL) × BL and (PLW × PL) × Dur, gilts and hogs, was determined. The results obtained for the examined traits in the feeding groups under comparison were slightly differentiated. The growth rate and feed conversion differed between the genetic groups in favour of crossbred fatteners with the proportion of Dur breed ($P \leq 0.01$). The mean backfat thickness from 5 measurements and loin "eye" area in fatteners derived from Dur sires as compared to hybrids coming from BL sires were significantly lower ($P \leq 0.01$) while the length of carcass was higher ($P \leq 0.01$). The gilts were characterized by better meatiness than boars: loin "eye" area, loin weight without backfat and skin, ham weight without backfat and skin differed on the level of $P \leq 0.05$, and meatiness of carcass and meatiness of basic cuts at $P \leq 0.01$. Significant ($P \leq 0.05$) or highly significant ($P \leq 0.01$) differences in the proportions of acids: $C_{18:2}$, $C_{18:3}$, $C_{20:4}$, $C_{22:4}$ and PUFA in the lipid fraction of MLD were found between the feeding groups. The proportion of the above-mentioned acids was lower in group E2 and higher in group E1 as compared to C. The proportion of the acid $C_{18:1}$ was significantly higher ($P \leq 0.05$) in group E2 as compared to E1. The demonstrated differences indicate the need of further studies in this respect. In pig fattening there is a possibility of effectively replacing feed antibiotics with other additives. The application of biostimulators – probiotic Bactocell or oligosaccharide Bio-Mos instead of the antibiotic flavomycin appeared to be favourable. From the production aspect it seems to be justified to supplement the feed rations for fatteners during the first stage of fattening with feed additives from the group of probiotics or prebiotics.

Keywords: fatteners; feed additives; fattening; slaughter value; meat quality

High requirements imposed on pork producers in the field of the quality of meat are favourable for the intensification of studies on feed additives, in particular substitutes of feed antibiotics (AGP) (Kjeldsen, 2002). In pig production, we may observe a constant decline of the application of feed antibiotics, with the increase in the use of antibiotics for therapeutic purposes (Bjornerot et al., 1996). In the light of available studies, the effectiveness of the alternative application of AGP biostimulators, among others from the group of probiotics and prebiotics is not, however, univocal (Kornegay and Risley, 1996; Houdijk et al., 1998; Harper and Estinne, 2002).

The aim of the undertaken studies was to determine the values of fattening and slaughter traits and the quality traits of pork meat produced by the fattening of crossbreds fed diets with the addition of the feed antibiotic flavomycin or its substitutes from the group of probiotics (Bactocell) or prebiotics (Bio-Mos).

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MATERIAL AND METHODS

An experiment was conducted on 48 pigs. The number of animals in the groups: control (C), experimental 1 (E1) and experimental 2 (E2) was 16. Porkers for fattening derived from 8 sows F1 crossbreds of Polish Large White × Polish Landrace (PLW × PL) coming from Duroc (Dur; 2 animals) and Belgian Landrace (BL; 2 animals) sires. The observations included 24 gilts and 24 hogs. The animals were classified into the groups by the method of analogues. The ratio of the animals of two genotypes and two genders was 1:1.

During the fattening period, the animals were managed individually. The pigs were fed individually in a two-stage system and feed was rationed. Two mixtures differing in the feeding value were used: for the first fattening period (from 21.5 kg to 57 kg of body weight) and for the second fattening period (from 57 kg to 100 kg of body weight). Feed ration was established on the basis of the body weight of animals (Polish Swine Nutrition Requirements, 1993). The feed mixtures for control fatteners contained a premix with addition of the antibiotic flavomycin and for the experimental animals a premix without antibiotic (Table 1). The fatteners from group E1 received the probiotic Bactocell with feed and those from group E2 the prebiotic Bio-Mos (during the first stage of fattening).

The experiment was ended with slaughtering, slaughter evaluation of carcasses and of selected quality traits of meat. In the right carcasses, after their cooling down, linear measurements were performed and then a partial dissection according to SKURZTCH (Różycki, 1996) was carried out. In 24 hours after slaughter, meat samples from the *Musculus longissimus dorsi* (MLD) were collected. The sample was collected at the level of the last three thoracic vertebrae. The following determinations were conducted: dry matter (PN-73/A-82110, 1973), crude protein by Kjeldahl method (PN-75/A-04018, 1975), crude fat by Washburn and Nix method (1974) and crude ash (PN-76/A-64795, 1976). In the lipid fraction of MLD, the profile of

Table 1. Composition of mixtures (%) and their feeding value

Specification	Control (C)		Experimental 1 (E1)		Experimental 2 (E2)	
	period I	period II	period I	period II	period I	period II
Barley meal	53.15	58.74	53.23	58.73	53.05	58.74
Wheat meal	25.0	25.0	25.0	25.0	25.0	25.0
Extracted soybean meal	11.5	6.0	11.5	6.0	11.5	6.0
Meat and bone meal	5.0	5.0	5.0	5.0	5.0	5.0
Premix with antibiotic[1]	5.0	5.0	–	–	–	–
Premix without antibiotic[2]	–	–	5.0	5.0	5.0	5.0
Probiotic Bactocell*	–	–	00.1	0.01	–	–
Bio-Mos**	–	–	–	–	0.1	–
L-lysine	0.3	0.26	0.3	0.26	0.3	0.26
DL-methionine	0.05	–	0.05	–	0.05	–
Energy content (MJ ME^x)	12.3	12.2	12.3	12.2	12.3	12.2
Protein, in total (%)	16.5	14.3	16.8	14.5	16.6	14.9

[1]Composition of 1 kg of the premix Lidermix T 5%: vitamins: A 210 000 IU; D_3 40 000 IU; E 2 000 IU; B_1 30 IU; B_2 80 IU; B_3 400 mcg; B_6 45 mg; B_{12} 500 mcg; K 32.5 mg; H 500 mcg; choline 1 500 mg; folic acid 9.0 mg; synthetic amino acids: methionine 7.50 g; lysine 36.0 g; threonine 5 000 mg; mineral components: Mn 1 500 mg; Zn 2 250 mg; Co 8.0 mg; Se 6.0 mg; Cu 500 mg; Fe 1 800 mg; J 20 mg; Mg (total) 1.0 g, P (total) 27.5 g; Na (total) 25.0 g; Ca (total) 122.0 g; other components: antioxidant 300 mg; Betafin S_1 3 750 mg; Flavomycin 100 mg; Ca pantothenate 200 mg; Pigor 757 – 4 000 mg; bran – 4 969 000 mg;

[2] as above, without Flavomycin; * Bactocell contains bacteria of the strain *Pediococcus acidilactici* MA 18/5M; **Bio-Mos contains cellular walls of *Saccharomyces cerevisiae* yeasts, strain 1 026; ^{x}energy content – values from the table of Polish Swine Nutrition Requirements (1993)

fatty acids was determined by gas chromatography according to PN-ISO 5509 (1996) and PN-ISO 5508 (1996).

The results were processed statistically by three-factor analysis of variance with the application of the least-squares method (SPSS 10.0). The effect of feeding group, genetic group and sex was considered in the analysis. The least-squares means (LSM) together with their standard errors (SE) and the comparison of changes in the values of traits in the experimental groups compared to the control group (%) were included in the tables.

RESULTS

In our studies the alternative application of the additive: probiotic or prebiotic instead of feed additive did not have any significant effects on the feed intake and daily gains and feed conversion by the fattening pigs (Table 2). The results of fattening were comparable in control and experimental groups. The growth rate and feed conversion were statistically significantly different between the genetic groups in favour of crossbred pigs coming from Dur sires as compared to the crossbreds derived from BL sires.

The mean body weight of fattened pigs amounted to 100.7 kg at slaughter and did not differ significantly between the groups C, E1 and E2. Small, statistically insignificant differences in slaughter traits were found between the groups receiving different feed additives (Table 3). Weight of loin without backfat and skin, of ham without backfat and skin, meatiness of carcass and basic cuts were somewhat better in groups E1 and E2 as compared to group C. The carcasses of animals fed the mixture with addition of flavomycin (group C) were characterised by the smallest loin "eye" area. In group E1 and E2, the loin "eye" area was larger by 1.10 cm^2 and by 3.29 cm^2, respectively (insignificant differences).

The mean body weight of fattened pigs with 50% proportion of Dur breed was higher by 2.4 kg in comparison with the weight of crossbreds coming from BL sires ($P \leq 0.01$). Only some slaughter traits differed significantly between the genetic groups (Table 3), e.g. fatness expressed as the mean backfat thickness from 5 measurements was higher in

Table 2. Results of fattening

Traits	Control (C)	Comparison of experimental groups with the control (%)		Fatteners from PLW × PL sows derived from sires of the breed		Sex		Total mean	
		E1/C	E2/C	Duroc	Belgian Landrace	hogs	gilts	LSM	SE
Feed intake									
Stage I (kg)	81.8	101.22	99.02	78.4^{a}	85.4^{b}	81.2	82.5	81.8	1.63
Stage II (kg)	133.9	104.18	104.03	132.0^{A}	143.1^{B}	140.6	134.6	137.6	1.99
Fattening (kg)	215.7	103.11	102.13	210.4^{A}	228.5^{B}	221.8	217.1	219.5	2.65
Feed consumed per 1 kg of gain									
Fattening period I (kg/kg)	2.35	99.57	97.02	2.24^{a}	2.40^{b}	2.34	2.30	2.32	0.036
Fattening period II (kg/kg)	3.04	105.92	104.61	2.95^{A}	3.35^{B}	3.20	3.10	3.15	0.042
Fattening (kg/kg)	2.73	103.30	101.83	2.64^{A}	2.92^{B}	2.82	2.73	2.77	0.032
Time of fattening duration (days)	101.4	101.97	102.56	99.0^{A}	106.8^{B}	103.9	102.0	102.9	1.27
Daily gains									
Fattening period I (g)	723	101.11	101.52	746	712	717	742	729	9.1
Fattening period II (g)	853	94.72	94.14	871^{A}	771^{B}	807	835	821	11.8
Fattening (g)	786	98.09	97.58	810^{A}	739^{B}	763	787	775	9.0

^{A,B}differences highly statistically significant at $P \leq 0.01$; ^{a,b}differences statistically significant at $P \leq 0.05$

C – control group (Flavomycin); E1 – experimental group I (Bactocell); E2 – experimental group II (Bio-Mos)

Table 3. Slaughter value

Traits	Control (C)	Comparison of e xperimental groups with control group (%)		Fatteners from PLW × PL sows from sires of the breeds		Sex		Total mean	
		E1/C	E2/C	Duroc	Belgian Landrace	hogs	gilts	LSM	SE
Weight of half-carcass (kg)	38.2	100.79	100.26	38.6	38.1	38.2	38.4	38.3	0.17
Weight of basic cuts (kg)	33.2	100.30	99.70	33.3	33.2	33.1	33.4	33.2	0.16
Dressing percentage (%)	75.9	100.53	100.26	75.7	76.5	75.8	76.4	76.1	0.24
Carcass length (cm)	78.4	101.53	100.00	80.5^{A}	77.1^{B}	78.6	79.0	78.8	0.37
Mean backfat thickness from 5 measurements (cm)	2.26	100.44	100.88	2.10^{A}	2.45^{B}	2.36	2.18	2.27	0.05
Loin "eye" area (cm^2)	49.17	102.24	106.69	47.69^{A}	53.57^{B}	48.60^{a}	52.67^{b}	50.63	0.83
Weight of loin without backfat and skin (kg)	4.8	104.17	106.25	5.0	5.0	4.9^{a}	5.1^{b}	5.0	0.05
Weight of backfat and skin from loin (kg)	1.5	100.00	100.00	1.4	1.5	1.6^{a}	1.4^{b}	1.5	0.03
Weight of ham without subcutaneous fat and skin (kg)	7.5	101.33	100.00	7.6	7.5	7.4^{a}	7.7^{b}	7.5	0.08
Weight of subcutaneous fat and skin from leg (kg)	1.6	100.00	93.75	1.5	1.6	1.6	1.5	1.5	0.03
Weight of meat in basic cuts (kg)	19.6	102.55	102.55	19.9	19.9	19.5^{a}	20.4^{b}	19.9	0.18
Meatiness of carcass (%)	51.1	102.35	102.74	51.7	52.3	50.9^{A}	53.0^{B}	52.0	0.38
Meatiness of basic cuts (%)	58.9	102.55	103.06	59.9	60.1	58.8^{A}	61.1^{B}	60.0	0.41

^{A,B}differences highly statistically significant at $P \leq 0.01$; ^{a,b}differences statistically significant at $P \leq 0.05$

C – control group (Flavomycin); E1 – experimental group I (Bactocell); E2 – experimental group II (Bio-Mos)

the group of fattened pigs with 50% proportion of BL breed as compared to the crossbreds with Dur breed proportion ($P \leq 0.01$). In the case of crossbreds with BL breed proportion, the loin "eye" area was also larger by 5.88 cm^2 in comparison with fatteners coming from Dur sires ($P \leq 0.01$).

The gilts were less fattened than the hogs and their loin "eye" area was larger by 4.07 cm^2 as compared to that of the hogs ($P \leq 0.01$). The gilts were characterised by higher (by 0.2 kg) weight of loin without backfat and skin and higher (by 0.3 kg) weight of ham without backfat and skin ($P \leq 0.05$). The meatiness of carcasses and basic cuts was better in the gilts as compared to the hogs; the differences were equal to 2.1 and 2.2 percent score, respectively ($P \leq 0.01$).

The fundamental composition of MLD was similar in groups receiving different feed additives (Table 4). Statistically significant differences between the feeding groups were found in the fatty acid profile in the lipid fraction of MLD, including acid 18:1, and acids from PUFA family (18:2, 18:3, 20:4, 22:4, 22:5).

DISCUSSION

The results of our studies were comparable with those obtained by different authors. Gomdo et al. (1995) reported that the combination of Lactobacilli and yeasts in diets for growing pigs improved weight gains. Estine et al. (1993) observed variable effects on fattening after the application of probiotic additive to feed rations. Bae et al. (1999) demonstrated that the fatteners fed diets with the addition of antibiotics showed better feed conversion and had higher weight gains as compared to the animals receiving 0.01% addition

Table 4. Basic composition and proportions of selected fatty acids in the acid profile and SFA, MUFA and PUFA in the lipid fraction of *musculus longissimus dorsi* (%)

Traits	Group			Fatteners from PLW × PL sows derived from sires of the breed		Sex		Total mean	
	C	E1	E2	Duroc	Belgian Landrace	hogs	gilts	LSM	SE
Dry matter	27.84	28.43	28.15	28.02	28.27	28.65^{A}	27.63^{B}	28.14	0.144
Crude protein	22.98	22.35	22.45	22.23^{a}	22.96^{b}	22.52	22.67	22.59	0.103
Crude fat	2.20	1.77	1.71	1.65^{a}	2.13^{b}	1.94	1.84	1.89	0.103
Crude ash	1.09	1.06	1.08	1.09	1.07	1.07	1.09	1.08	0.008
$C_{16:0}$	25.70	25.17	26.08	25.66	25.63	25.39	25.90	25.65	0.192
$C_{16:1}$	2.92	2.75	2.85	2.91	2.77	2.83	2.85	2.84	0.040
$C_{18:0}$	14.95	14.95	15.32	14.93	15.22	14.87	15.28	15.07	0.136
$C_{18:1}$	40.97	40.17^{a}	41.54^{b}	40.89	40.90	41.03	40.77	40.90	0.226
$C_{18:2}$	6.07^{A}	6.41^{A}	5.63^{B}	5.96	6.11	6.13	5.94	6.04	0.084
$C_{18:3}$	0.57	0.69^{a}	0.50^{b}	0.63	0.56	0.66	0.52	0.59	0.048
$C_{20:4}$	0.57	0.78^{a}	0.51^{b}	0.65	0.59	0.62	0.63	0.62	0.046
$C_{22:4}$	0.62	0.82^{a}	0.50^{b}	0.63	0.66	0.65	0.64	0.65	0.050
$C_{22:5}$	0.64^{a}	0.75^{A}	$0.46^{B,b}$	0.63	0.61	0.61	0.63	0.62	0.035
SFA	43.87	43.84	44.31	43.95	44.07	43.59	44.42	44.01	0.233
MUFA	45.36	44.50	45.73	45.27	45.13	45.33	45.06	45.20	0.217
PUFA	8.47^{a}	9.46^{A}	$7.61^{B,b}$	8.49	8.54	8.67	8.35	8.51	0.192

^{A,B}differences highly statistically significant at $P \leq 0.01$; ^{a,b}differences statistically significant at $P \leq 0.05$

C – control group (Flavomycin); E1 – experimental group I (Bactocell); E2 – experimental group II (Bio-Mos); SFA: sum of $C_{12:0}$, $C_{14:0}$, $C_{16:0}$, $C_{17:0}$, $C_{18:0}$, $C_{20:0}$; MUFA: sum of $C_{16:1}$, $C_{17:1}$, $C_{18:1}$, $C_{20:1}$; PUFA – $C_{18:2}$, $C_{18:3}$, $C_{20:4}$, $C_{22:4}$, $C_{22:5}$

of mannanoligosaccharides. Caleesen and Hansen (1999) reported comparable growth rates in fatteners receiving feed rations with the addition of Bio-Mos or without it and Davis et al. (2001) found out small improvement of the fattening results after the application of the above-mentioned additive. Feed conversion and daily gains of fatteners fed diets with the addition of antibiotics or without them or with the addition of Bio-Mos, as obtained by Youzela et al. (2002), were also similar.

Różycki and Tyra (2002) reported that Dur pigs achieved higher weight gains while BL pigs had lower gains, with the comparable feed conversion per 1 kg of gain. Differences in the growth rate of animals of different sex observed in our studies were confirmed by Youzela et al. (2002), who showed that the gilts reached slaughter weight significantly earlier than the hogs.

In our studies, slight differentiation of slaughter traits between the feeding groups was found. On the other hand, Jasek et al. (1992) applied diets containing the addition of the probiotic Biogen T to growing pigs and they stated the improvement of slaughter traits, *inter alia* of backfat thickness by 3.6% and loin "eye" area by 7.6%. Grela et al. (2001) applied mannanoligosaccharide to feeds for growing pigs and reported an increase in the ham weight of fatteners.

Bzowska and Ptak (2001) informed that BL gilts were more fattened compared to Dur gilts whereas Różycki and Tyra (2002) stated that the fattening of pigs of both breeds was comparable. In own experiment, the fatteners with 50% proportion of BL breed were more fattened. The Pietrain and Belgian Landrace pigs are known, however, to have very good meatiness. According to Kulisiewicz et al. (1995), the crossbred animals with 50% propor-

tion of Duroc breed are characterised by worse slaughter traits than the fatteners derived from the Pietrain sires. Eckert and Orzechowska (2002) also found a smaller depth of MLD and lower meatiness of fatteners (PLW × PL) × Dur in comparison with the crossbreds (PLW × PL) × Pietrain. According to Gou et al. (1995), the hams of fatteners derived from Duroc sires were characterised by weak muscling and conformation. Eckert and Orzechowska (2002) reported a higher depth of MLD and meatiness of carcasses of the gilts compared to the castrates. Gou et al. (1995) also indicated a greater fattening of hams of the hogs than of the gilts.

In respect of the percentage meat content in basic cuts, Kulisiewicz et al. (1995) demonstrated a significant interaction of genotype × feeding. In the authors' opinion, it proved the need to differentiate feeding for genetically different animals.

In the situation of the lack of significant differences in the chemical composition of fatteners' meat in the feeding groups and its certain differentiation in genetically different pigs and gilts and hogs, we may state that it was typical of pork meat. Jasek et al. (2002) also showed a different chemical composition of meat from MLD in Dur and BL fatteners and in crossbreds with the proportion of the above-mentioned breeds.

In our studies, the intensified activity of lactic bacteria (group E1 and E2) could affect the processes of ingestion and absorption as well as indirectly influence the profile of fatty acids (Table 4). Batorska et al. (2003) employed acidifying or herbal additives in diets for fatteners, instead of the feed antibiotic, and they did not find any effect of these additives on the profile of fatty acids. Interactions between feeding and genotype in respect of the content of certain fatty acids were indicated by Sawosz et al. (1995).

Summing up the results of our studies, it should be stated that there was a small differentiation of growth rate and feed conversion in fatteners receiving different feed additives. The differences in fattening traits of the crossbred pigs derived from BL and Dur sires in favour of fatteners with 50% proportion of the Dur breed were demonstrated. A tendency of favourable changes in slaughter traits was found in the experimental animals fed diets with the addition of Bactocell (group E1) or Bio-Mos (group E2) as compared to the control group (C) receiving the addition of the feed antibiotic flavomycin. The fatteners coming from Dur sires as compared to the hybrids derived from BL had longer carcasses ($P \leq 0.01$), lower backfat thickness ($P \leq 0.01$) and smaller loin "eye" area ($P \leq 0.01$). It was also demonstrated that the gilts were characterised by more favourable slaughter traits compared to the hogs. The basic chemical composition of pork meat of the fatteners in the groups fed diets with the addition of feed antibiotic (group C) or substitutes (group E1 and E2) was similar. The stated differences in the fatty acid profile in the lipid fraction of meat between the groups receiving different feed additives in the full-ration mixtures (including from the group of probiotics and prebiotics) indicated the need of further studies in this respect.

In pig fattening there is a possibility of effectively replacing feed antibiotics with other additives. The alternative application of biostimulators – probiotics (Bactocell) or mannanoligosaccharide (Bio-Mos) instead of the antibiotic flavomycin appeared to be favourable.

From the production aspect it seems to be justifiable to supplement the feed rations for fatteners during the first stage of fattening with feed additives from the group of probiotic or prebiotic substances.

REFERENCES

Bae K.H., Ko T.G., Kim J.H., Cho W.T., Han Y.K., Han I.K. (1999): Use of metabolically active substances to substitute for antibiotics in finishing pigs. Korean J. Anim. Sci., *41*, 23–30.

Batorska M., Więcek J., Rekiel A., Kulisiewicz J. (2003): The influence of addition of selected growth stimulants on pig fatteners' production results and fatty acids profile. Pol. J. Food Nutr. Sci., *53*, 25–27.

Bjornerot L., Franklin A., Tysen E. (1996): Usage of antibacterial and antiparasitic drugs in animal in Sweden between 1988 and 1993. Vet. Res., *139*, 282–286.

Bzowska M., Ptak J. (2001): Wyniki oceny trzody chlewnej w 2000 roku. KCHZ Warszawa, 1–76.

Caleesen J., Hansen C.F. (1999): Aromax®. New trial result jully1, Danske Slagterier – Danish Slaughteries. The National Committee For Pig Breeding, Health and Production, Danmark. http://www.delacon.com/int/trials/a36e_1.pdf

Davis M.E., Maxwell C.V., de Rodas B.Z., Brown D.C., Johnoson Z.B., Dvorak R.A. (2001): Efficiency of mannan oligosaccharide (Bio-Mos®) addition with two levels of copper sulphate in the diets of growing-finishing pigs. J. Anim. Sci., *79*, 472.

Eckert R., Orzechowska B. (2002): Mięsność tusz loszek i kastratów od mieszańcowych loch wbp × pbz, po knurach rasy duroc bądź pietrain. Prace i Mater. Zoot., Zeszyt Specjalny, *13*, 37–41.

Estine M.J., Hartsock T.G., Douglas J.B. (1993): Effect of treatment with a probiotic on survival and growth rates in nursing pigs. In: Estine M.J., Hartsock T.G. (eds.): Swine Report. University of Maryland. 26–27.

Gomdo S., Tossenberger J., Szabo C. (1995): Effects of probiotics and yeast culture on the performance of pigs and dairy cows. Krmiva, *37*, 13–17.

Gou P., Guerrero L., Arnau J. (1995): Sex and crossbreed effects on the characteristics of dry-cured ham. Meat Sci., *40*, 21–31.

Grela E., Krasucki W., Semeniuk V., Pecka S., Matras J. (2001): Influence of some immunomodulation additives to growing-finishing diets on pig performance, carcass traits and some blood indices. J. Anim. Feed Sci., *10,* 231–236.

Harper A., Estinne M. (2002): Alternatives to antimicrobial growth promoters not as effective as traditional antimicrobial additives for nursery pig. Livestock Update, May. http://www.ext.vt.edu/news/periodicals/livestock/asd-02-05/asp-100.html

Houdijk J.G.M., Bosch M.W., Verstegen M.W.A., Berenpas H.J. (1998): Effects of dietary oligosaccharides on the growth performance and faucal characteristics of young growing pigs. Anim. Feed Sci. Technol., *71,* 35–48.

Jasek S., Kalinowska R., Knecht D., Pawiak R. (1992): Wpływ dodatku probiotyku Biogen na efekty produkcyjne i wskaźniki fizjologiczne trzody chlewnej. 1. Wpływ dodatku probiotyku Biogen na wskaźniki użytkowości loch i wyniki odchowu prosiąt. Roczn. Nauk. Zoot., Monogr. i Rozpr., *31,* 217–228.

Jasek S., Krasnowska G., Natoloczna-Kotara A., Kaniak-Polok M. (2002): Ocena wybranych wskaźników użytkowości rzeźnej i jakości mięsa tuczników pięciu grup genetycznych. Prace i Mater. Zoot., Zeszyt Specjalny, *13,* 55–61.

Kjeldsen N. (2002): Producing pork antibiotic growth promoters: the Danish experience. Adv. Pork Prod., *13,* 107–115.

Kornegay E.T., Risley C.R. (1996): Nutrient digestibilities of a corn-soybean meal diet as influenced by Bacillus products fed to finishing swine. J. Anim. Sci., *74,* 799–805.

Kulisiewicz J., Sokół J.L., Rekiel A., Iniarski R., Lenartowicz P. (1995): Growth rate and carcass value of three types of crossbred pigs fed ad libitum diets with different protein and energy contents. J. Anim. Feed Sci., *4,* 11–19.

PN-73/A-82110, PKNMiJ, Warszawa, 1973.

PN-75/A-04018, PKNMiJ, Warszawa, 1975.

PN-76/R-64795, PKNMiJ, Warszawa, 1976.

PN-ISO 5508: Oleje i tłuszcze roślinne oraz zwierzęce. Przygotowanie estrów metylowych kwasów tłuszczowych. Warszawa, Grudzień, 1996.

PN-ISO 5509: Oleje i tłuszcze roślinne oraz zwierzęce. Analiza estrów metylowych kwasów tłuszczowych metodą chromatografii gazowej. Warszawa, Grudzień, 1996.

Różycki M. (1996): Zasady postępowania przy ocenie świń w Stacjach Kontroli Użytkowości Rzeźnej Trzody Chlewnej. Stan hodowli i wyniki oceny świń. IZ XIV, 69–82.

Różycki M., Tyra M. (2002): Wyniki oceny użytkowości tucznej i rzeźnej świń w stacjach kontroli. Stan hodowli i wyniki oceny świń w roku 2001. IZ Kraków. 1–93.

Sawosz E., Chachułowa J., Kulisiewicz J., Sokół J.L., Skomiał J. (1995). Wpływ dodatku tłuszczu wieprzowego do dawki na skład kwasów tłuszczowych i zawartość cholesterolu w longissimus dorsi u świń różnych typów. In: XXV. Sesja Nukowa Komisji Żywienia Zwierząt KNZ PAN Koncentraty białkowe i energetyczne w mieszankach treściwych i dawkach pokarmowych, 08.–09. 11. Poznań. 165–166.

Washburn K.W., Nix D.F. (1974): A rapid technique for extraction of yolk cholesterol. Poult. Sci., *53*, 1118–1122.

Youzela C., Teves P., Silva M., Rego O., Borba A. (2002): The effect of mannanoligosaccharide (Bio-Mos) on growth performances and carcass characteristics in pigs. Books of Abstracts, Wageningen, Pers 8. N4.49.

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