

THE EFFECT OF PROTEIN FEEDS ON FATTENING RESULTS AND POST-SLAUGHTER EVALUATION IN SWINE*

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Three groups of crossbreeds of wbp x pbz breeds (10 fattening pigs in each group) were fed Starter (30–70 kg) and Finisher (71–105 kg of body weight) all-mash which contained triticale meal, barley and different kinds of protein feeds. Fattening pigs of the control group (K) were given mixtures with extracted soybean meal, W groups – mixtures with rapeseed cake and fodder pea. Meat-bone meal was introduced into all Starter mixtures. It was proved that independently of whether the mixtures contained extracted soybean meal or rapeseed cake with pea, similar and high body gains (778 and 783 g) of swines were obtained. The introduction of 25% of rapeseed cake instead of soybean meal significantly decreased the body weight gain (709 g), and simultaneously the most beneficial effect on post-slaughter indices was found. Moreover, a decrease in fatness and an increase in the number of polyunsaturated fatty acids in muscles were proved, and the proportion of PUFA n-6/n-3 amounted to 10:1 instead of 16:1 in the control group. The application of rapeseed cake with pea resulted in an increase in meat content (53.1% instead of 51.2% in K group) and in the improvement of meat palatability.

INTRODUCTION

Recently a high price of extracted soybean meal has brought about greater utilization of local protein feeds in fattening pig feeding. There are products derived from the oil rendering from rapeseeds (extracted meal and rapeseed cake) and legume seeds. Rapeseed cake contains a considerable amount of protein (28–31%) and energy (14–17 MJ EM), and the feed is rich in sulfur amino acids. Nowadays, an interest is being noticed in employing fodder pea seeds, because new strains are characterised by a considerable protein content, protein rich in lysine, and by a low level of crude fibre and antinutritional factors [Carrouee, 1995].

So far, the research has proved that there was a possibility of using the feed as one of mixture components in swine feeding, however, there are few studies [Sobotka & Tywoń-czuk, 1997; Sobotka, 1998], in which the usefulness of mixtures containing together rapeseed cake and fodder pea were estimated.

The studies aimed at evaluating the fattening results and post-slaughter quality of swine fed mixtures containing rapeseed cake or rapeseed cake and fodder pea as substitutes of extracted soybean meal.

MATERIAL AND METHODS

The experiment was carried out on 30 fattening crossbred pigs originating from the crossbreeding of wbp and pbz breeds. The animals were divided into 3 feeding groups of the same numbers. Kinds of protein feeds were the differential factor in all-mash containing triticale and barley (Table 1).

The feeds used in Starter mixtures were as follows: in the control group (K) – extracted soybean meal, in W group – 25% of rapeseed cake, and in WG group – 20% of rapeseed cake and 20% of fodder pea. Animal protein in the form of meat-bone meal was introduced into all mixtures. In the second fattening period, the animal meal was utterly eliminated, and the protein feeds compared in the experimental groups remained unchanged. The mixtures were balanced on the basis of Swine Feeding Standards [1993]. The loose mixtures were applied *ad libitum* with a constant access to water in nipple drinkers. After reaching 105 kg of body weight, 4 fatteners were randomly chosen from each group in order to carry out a simplified slaughter analysis. In the experiment, production results (daily body gains, consumption of feed, energy and protein per 1 kg of body gain) and some parameters of post-slaughter evaluation (dressing percentage, carcass leanness, backfat thickness, loin area, fat weight and internal organs weight) were estimated. Carcass leanness was measured by Ultra-Fom 100, and the carcasses were classified according to the EUROP system. Samples of *longissimus dorsi* muscle and *adductor* muscle were collected in order to determine the chemical composition of the muscles and fatty acids content in fatty fractions. The analysis of the basic chemical composition of the muscles was carried out by weendeńska's method, whereas fatty acids composition by thin layer chromatography for the division of the fatty fraction. Both in muscles and in blood serum triglyceride content, total cholesterol content and its fractions (HDL, LDL) were estimated by enzymatic methods. Sensory evaluation of meat (in a 5-point scale) after cooking in 0.8% of NaCl was also performed according to Baryłko-Pikielna [1975]. The results obtained were

TABLE 1. Raw material composition and nutritive value of mixtures used in the experiment [%].

Raw materials	Mixed feeds					
	Starter			Finisher		
	K	W	WG	K	W	WG
Triticale meal	30	30	30	30	30	30
Barley meal	50	40	24.5	54	42.5	27.5
Soybean meal	15	-	-	13.5	-	-
Meat-bone meal	2	2	2.5	-	-	-
Rapeseed cake	-	25	20	-	25	20
Fodder pea seeds	-	-	20	-	-	20
Aminokraft premix	3	3	3	2.5	2.5	2.5
Total	100	100	100	100	100	100
1 kg of mixture contains:						
Metabolizable energy [MJ]	12.49	13.26	13.03	12.51	13.31	13.00
Crude protein [%]	17.23	17.03	18.12	15.94	15.95	17.25
Crude fibre [%]	3.56	5.16	4.89	3.70	5.27	5.03
Lysine [%]	0.93	1.03	0.97	0.79	0.95	0.91
Methionine + cystine [%]	0.56	0.63	0.66	0.53	0.61	0.65
Calcium [%]	0.84	0.89	0.94	0.61	0.60	0.60
Phosphorus [%]	0.61	0.53	0.56	0.53	0.41	0.44
Sodium [%]	0.14	0.17	0.17	0.14	0.13	0.14

analysed statistically by one-factor analysis of variance, and significance of differences between groups was calculated on the basis of Duncan's test [Ruszczyc, 1981].

RESULTS AND DISCUSSION

Table 2 illustrates the fattening results obtained in the study, which were characterised on the basis of the average daily body gains, the consumption of feed, total protein and metabolizable energy per 1 kg of body gain. The highest average body gains (783 g) were proved in the group of fatteners fed mixtures containing rapeseed cake and fodder pea. In comparison with this group, animals of the control group had similar body gains (778 g), whereas fattening pigs fed rapeseed cake had significantly smaller body gains (709 g).

Significant differences between groups regarding feed and crude protein consumption per 1 kg of body gain were not found. Significantly larger consumption of metabolizable energy by fattening pigs fed mixtures containing rapeseed cake was due to a larger content of metabolizable energy in the mixtures. The tendency towards a slight decrease in body gains and towards an increase in feed and energy consumption per 1 kg of body gain in animals fed mixtures containing rapeseed cake, which entirely replaced soybean meal, was found by Sokół *et al.* [2001]. Osek *et al.* [1999] stated, however, that the total substitution of soybean meal by rapeseed cake did not significantly affect daily body gains of the fattening pigs. Grela *et al.* [1996], who applied 8 or 15% of rapeseed cake as a partial substitution product of extracted soybean meal, did not prove any effect of the feed

TABLE 2. The results of fattening and of post-slaughter value.

Specification	Groups		
	K M ± SD	W M ± SD	WG M ± SD
Daily gains during the total fattening period [g]	778 ± 60.38 ^a	709 ± 88.89 ^b	783 ± 52.91 ^a
Feed conversion per 1 kg of body weight gain:			
- mixtures [kg]	3.42 ± 0.26	3.42 ± 1.10	3.46 ± 0.24
- metabolizable energy [MJ]	42.74 ± 3.33 ^b	48.69 ± 10.04 ^a	44.99 ± 3.18 ^{ab}
- crude protein [g]	555 ± 43.24	560 ± 111.58	607 ± 42.91
Dressing percentage [%]	77.0 ± 1.24	76.60 ± 0.55	75.30 ± 0.76
Meatness [%]	51.20 ± 1.35	51.60 ± 1.88	53.10 ± 5.41
Mean thickness of back fat from 5 measurements [cm]	2.92 ± 0.85 ^a	2.36 ± 0.27 ^b	2.62 ± 0.60 ^{ab}
Lard weight [g]	1686 ± 381.65	1320 ± 272.76	1437 ± 497.28
Area of loin eye [cm ²]	42.30 ± 1.29	44.84 ± 0.92	42.80 ± 12.72
Weight of internal organs [g]			
- kidney	328 ± 17.5 ^{ab}	374 ± 9.46 ^a	317 ± 40.31 ^b
- liver	1681 ± 100.13 ^b	2046 ± 212.34 ^a	1827 ± 192.07 ^{ab}
- thyroid	14.02 ± 2.76 ^b	18.32 ± 3.66 ^{ab}	23.10 ± 3.62 ^a

a, b – mean values in the same row with different letters differ significantly at p≤0.05

on daily gains of the animals neither. Moreover, Tywończuk *et al.* [1994] found that a partial substitution of soybean meal by rapeseed cake resulted in larger average daily body gains of swines.

The positive results of post-slaughter performance resulted from the introduction of local protein feeds into mixtures for fattening pigs. Despite the fact that carcass leanness did not differ significantly between the groups, the trait was larger by 0.4–1.5% in animals fed mixture containing rapeseed cake or rapeseed cake and pea. Fattening pigs of the experimental groups (especially those fed mixtures containing rapeseed cake) were less fatty because of lower backfat thickness and fat weight. The results were confirmed by Lipiński and Tywończuk [1997] and Dorszewski *et al.* [1997]. The authors also proved that the application of rapeseed cake in swine feeding caused an increase in carcass leanness and a decrease in backfat thickness.

The studies stated once again that the weight of internal organs increased upon the application of rape feeds in mixtures. A higher liver weight (by 8 and 18%) and thyroid weight (by 23.5 and 39%) of the experimental animals were reported.

The chemical composition of *longissimus dorsi* and *adductor* muscles (Table 3) showed the effect of the mixtures on dry matter, crude ash and crude protein of the muscles. A significantly larger crude protein content and a significantly lower crude ash in *longissimus dorsi* muscle of fattening pigs of the W group in comparison with pigs of the WG group, whose muscles contained the highest level of dry matter (27.35%) and crude ash (1.19%), were proved. According to Brzóska *et al.* [1998] *longissimus dorsi* muscle contained 2.4–4.2% of fat, thus very good results were obtained in the presented studies. A significant increase was found in dry matter content in *adductor* muscle of pigs fed mixtures with 25% of rapeseed cake in comparison with fattening pigs of the WG group, whose muscle contained the largest level of crude protein with the significant difference in relation to the control group.

The kinds of mixtures had a considerable effect on fatty acids content in lipids of the analysed muscles. Significantly more unsaturated fatty acids were found in both muscles of

fattening pigs fed mixtures containing 25% of rapeseed cake. The increase in polyunsaturated fatty acids, especially linolenic acid, was worthy of notice. Almost three times more of the linolenic acid in *longissimus dorsi* muscle and twice more in *adductor* muscle, in comparison with the fattening pigs of the control group, were proved.

A higher content of linolenic acid in the fattening pigs fed mixtures containing rapeseed cake and fodder pea was also reported, however, the differences in relation to the remaining groups were not statistically significant. It was found the most advisable (10:1) relation of polyunsaturated fatty acids of n-6 group to n-3 group in swines fed mixtures in which extracted soybean meal was substituted only by rapeseed cake. According to WHO, the ratio should amount to 6:1–4:1. Thus, every step that tends towards its narrowing serves a purpose. Nürnberg *et al.* [1997] and Osek *et al.* [1999] showed an increase in unsaturated fatty acids content in muscles after introducing rapeseed cake into the feed ration. Nürnberg *et al.* [1997] stated that the introduction of 20% of rapeseed cake resulted in an increase in PUFA by over 2%. However, a considerable increase in the acids together with an increase in rapeseed cake in mixtures (16 and 20%, respectively) was found by Osek *et al.* [1999]. Adams *et al.* [1989] and Brzóska [1998] showed that polyunsaturated fatty acids had anticholesterol and antisclerotic impacts. From the swine meat consumer point of view, the results obtained in the presented experiment may be found beneficial.

Moreover, the content of triglycerides in serum decreased as a result of the introduction of rapeseed cake instead of soybean meal (Table 4). Compared with fattening pigs fed mixtures containing extracted soybean meal, a significant decrease (by 66%) in the triglycerides in pigs given rapeseed cake and pea in mixtures was proved. The lowest level of the total cholesterol (110.2 mg/100 mL) and low-molecule HDL fraction (28.8 mg/100 mL) in the W group were found. Similarly to these results, Sokół *et al.* [2001] also reported a decrease in the total cholesterol content in blood serum after the application of rapeseed cake into mixtures. In addition, Kliber *et al.* [1994] found

TABLE 3. The content of nutrients and fatty acids in muscles [%].

Specification	<i>Longissimus dorsi</i>			<i>Adductor</i>		
	K M ± SD	W M ± SD	WG M ± SD	K M ± SD	W M ± SD	WG M ± SD
NUTRIENTS						
Dry mater	26.42±0.66 ^b	26.56±0.13 ^{ab}	27.35±0.35 ^a	25.96±0.27 ^{ab}	26.47±0.29 ^a	25.75±0.18 ^b
Crude ash	1.15±0.03 ^{Aba}	1.10±0.01 ^{Bb}	1.19±0.01 ^{Aa}	1.12±0.03	1.14±0.03	1.15±0.05
Crude protein	23.86±0.59 ^{ab}	24.28±0.13 ^a	23.48±0.59 ^b	22.43±0.6 ^b	22.84±0.20 ^{ab}	23.34±0.53 ^a
Crude fat	1.13±0.09	1.05±0.14	1.20±0.23	1.47±0.19	1.48±0.21	1.09±0.43
FATTY ACIDS						
– Linoleic	5.92±0.68 ^b	10.09±1.43 ^a	8.30±2.00 ^{ab}	7.22±1.47 ^b	10.40±1.05 ^a	9.30±1.01 ^{ab}
– Linolenic	0.37±0.04 ^b	1.01±0.18 ^a	0.66±0.11 ^{ab}	0.52±0.08 ^{Bb}	0.96±0.12 ^{Aa}	0.69±0.06 ^{ABb}
Saturated (SFA)	37.08±1.59 ^A	32.00±0.91 ^B	36.59±0.81 ^A	35.70±2.32 ^a	30.35±0.93 ^b	34.42±1.44 ^a
Unsaturated (UFA)	62.57±1.54 ^B	67.77±0.88 ^A	63.11±0.82 ^B	64.10±2.29 ^b	69.27±0.99 ^a	65.27±1.49 ^b
MUFA	54.53±1.27	55.56±1.09	52.89±1.66	55.21±0.93	56.60±0.30	54.12±1.97
PUFA	8.04±0.86 ^b	12.21±1.73 ^a	10.22±2.38 ^{ab}	8.89±1.60 ^b	12.67±1.21 ^a	11.15±1.00 ^{ab}
PUFA n-6/n-3	16	10	13	14	11	13

a, b – mean values in the same row with different letters differ significantly at $p \leq 0.05$; A, B – mean values in the same row with different letters differ significantly at $p \leq 0.01$.

TABLE 4. The content of triglycerides and cholesterol in blood serum and muscles.

Specification	Groups		
	K M ± SD	W M ± SD	WG M ± SD
BLOOD SERUM [mg/100 mL]			
– Triglycerides	70.4 ± 25.69 ^a	54.8 ± 10.34 ^{ab}	24.0 ± 16.55 ^b
– Cholesterol			
Total	113.4 ± 3.61 ^{Bbv}	110.2 ± 14.93 ^{Bb}	157.7 ± 14.10 ^{Aa}
HDL	44.0 ± 9.25 ^{ABab}	28.8 ± 4.11 ^{Bb}	55.7 ± 21.06 ^{Aa}
LDL	59.7 ± 5.95 ^{Bb}	61.2 ± 17.21 ^{ABb}	100.0 ± 24.04 ^{Aa}
<i>Longissimus dorsi</i> [mg/100 g]			
– Triglycerides	346.15 ± 15.79	361.80 ± 62.27	348.71 ± 24.79
– Cholesterol			
Free	10.26 ± 1.03 ^b	15.40 ± 2.99 ^a	8.53 ± 0.60 ^b
Related	1.66 ± 0.31	2.10 ± 0.09	2.03 ± 0.30
Total	11.92 ± 0.85 ^{Bb}	13.50 ± 2.93 ^{Aa}	10.56 ± 0.75 ^{Bb}
<i>Adductor</i> [mg/100 g]			
– Triglycerides	278.05 ± 24.87 ^b	290.3 ± 47.96 ^b	340.96 ± 13.46 ^a
– Cholesterol			
Free	11.36 ± 1.58	11.0 ± 0.29	9.99 ± 0.92
Related	2.03 ± 0.27 ^{ABb}	1.60 ± 0.09 ^{Bb}	2.94 ± 0.80 ^{Aa}
Total	13.40 ± 1.82	12.60 ± 0.37	12.94 ± 1.71

a, b – mean values in the same row with different letters differ significantly at $p \leq 0.05$; A, B – mean values in the same row with different letters differ significantly at $p \leq 0.01$.

that the introduction of rapeseeds into mixtures for fattening pigs caused a decrease in triglyceride and cholesterol contents. The application of experimental mixtures also decreased the total and free cholesterol contents in *adductor* muscle. Although the differences between the groups were not proved statistically, the level of total cholesterol decreased by 3% in the WG group and by 6% in the W group, and the level of free cholesterol – by 12 and 3%, respectively.

Recently consumers have been paying much more attention to meat quality, therefore the verification of meat

in respect of its taste was a complement to the post-slaughter evaluation. The results were shown in Figures 1 and 2. The best sensory evaluation was reported in both *longissimus dorsi* muscle and *adductor* muscle of swines fed mixtures containing 20% of rapeseed cake and 20% of pea.

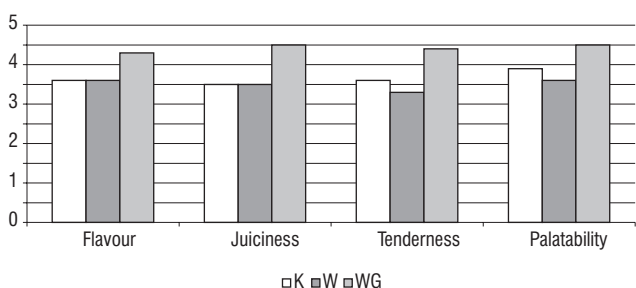
CONCLUSIONS

The obtained results showed that the substitution of extracted soybean meal by rapeseed cake and fodder pea resulted in very good live and post-slaughter performance, however, the application of rapeseed cake only decreased the daily body gains of swine on the one hand and had the most beneficial impact on the meat quality of the fattening pigs on the other.

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FIGURE 1. The results of sensory evaluation of *longissimus dorsi* muscle.FIGURE 2. The results of sensory evaluation of *adductor* muscle.

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WPLYW RODZAJU PASZ BIAŁKOWYCH NA WYNIKI TUCZU I OCENĘ POUBOJOWĄ ŚWIŃ

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Trzy grupy tuczników (10 sztuk w każdej) mieszańców ras wbp x pbz, żywiono mieszankami pełnoporcjowymi typu Starter (30–70 kg) i Finisz (71–105 kg m.c.) zawierającymi w składzie pszenżyto i jęczmień oraz różne pasze białkowe. Grupa kontrolna otrzymywała mieszanki z poekstrakcyjną śrutą sojową, grupa W – z wytlókiem rzepakowym, a grupa WG – z wytlókiem rzepakowym i grochem pastewnym. Do wszystkich mieszanek Starter wprowadzono mączkę mięsno-kostną. Wykazano, że niezależnie czy mieszanki zawierały w składzie poekstrakcyjną śrutę sojową czy wytlók rzepakowy z grochem, to świni żywione nimi uzyskały podobne i bardzo dobre przyrosty dobowe (778 i 783 g). Wprowadzenie 25% wytlóku rzepakowego w miejsce śrutę sojowej istotnie obniżyło przyrost masy ciała zwierząt (709 g), przy jednoczesnie najkorzystniejszym wpływie na wskaźniki poubojowe (tab. 2). Zmniejszyło się odtuszczenie, wzrosła ilość wielonienasyconych kwasów tłuszczowych w mięśniach, a proporcje PUFA n-6/n-3 wynosiły 10:1 wobec 16:1 w grupie kontrolnej. Z kolei zastosowanie wytlóku z grochem zwiększyło % mięsa w tuszy – 53,1% wobec 51,2% w grupie K (tab. 2) oraz jego smakowitość (rys. 1, 2).