THE IMPACT OF THE SUBSTITUTION OF SOYABEAN MEAL FOR MEAT-AND-BONE MEAL ON PERFORMANCE AND CARCASS VALUE OF GROWING-FINISHING PIGS*

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The aim of the study was to analyse the effect of substituting vegetable protein for meat-bone meal on the parameters being achieved in the fattening performance and carcass value in fattening of final pig hybrids. The study included in total 72 hybrid pigs of the (LW_s x PN) x (LW_d x L) genotype of balanced sex at the age of 68 days and total average live weight of 24.15 kg. It has been found out that substituting vegetable protein for animal protein has almost no impact on the feed intake or on the growth intensity, i.e. the average daily weight gain (921 g and 914 g, respectively) was not proved, either. Animals fed with complete feeding mixture (CFM) without animal protein recorded lower values of meat formation (56.8% and 55.3%, respectively) and deposited more fat to the detriment of meat formation. In contrast, the pigs fed with animal protein achieved higher share of meat, bigger loin eye area and higher height of the *musculus longissimus lumborum et thoracis* (MLLT) meat and a markedly lower height of the back fat (11.6 mm and 12.6 mm, respectively) throughout the whole period of growth. During the test they also showed at individual monitored week intervals a higher intake of protein and this increased intake was reflected in a higher meat formation in the carcass.

pig; feeding; fattening capacity; carcass value

INTRODUCTION

Nutrition factors have both direct and indirect effect of different intensity on the fattening performance, quantitative and qualitative aspects of the carcass value in the course of the growth of pigs. Of a provably direct effect on the fattened pigs is the standard of nutrition, highly nutritious diets, health-hygienic parameters of feed, its selection and technological processing, feeding technique and technology.

An optimal composition of the carcass of meaty pigs may be achieved only in case of ensuring of the supply of individual nutrients in compliance with the requirements of metabolism and energy. The failure to comply with these requirements result in the decrease of the values of production traits achieved and, consequently, of the economic effect (Zeman, Hodboď, 2001).

Heger (2001) states that the composition of compound feeds, apart from favourable economic parameters, must meet at least two additional criteria. First, the composition of compound feed has to contribute to the achievement of the required quality of the carcass (meat – fat ratio) and, secondly, it also has to minimize the environmental contamination by nitrogen and phosphor from the animal faeces.

According to Heger et al. (1990) the most important indicator of the potential production traits is the process of depositing of proteins in the body from the birth until the end of the fattening period. Derived from these values are subsequently other parameters characterizing the composition of the pig bodies, i.e. lean meat growth, deposition of fat, mineral substances etc.

Kodeš et al. (2001) state that nitrogenous substances have an irreplaceable function in the nutrition of pigs as the source of proteins and amino acids, in particular. As an optimal amount of nitrogenous substances in the ration is generally considered such an amount that is able to cover fully the needs of essential amino acids of the given organism (Noblet, 2002).

Absorption of amino acids is increased by carnitin which is a part of the animal feed. It has a favourable effect on protein retention, absorption and deposition and reduces fat production (Bachnudsen, Jorgensen, 1998).

L-carnitin of B_T vitamin is trimethylbetain (beta-OH--gamma-trimethylamino butanoic acid) which is in fact water-dissolvable and is endogenously synthetsized in the body. Initially, it was identified in the muscles of mammals and occurs also in the body of birds, fish, reptiles, insect, micro-organisms and plants. The centre of L-carnitin synthesis is in liver, although the initiator of its synthesis (L-lysine) originates mainly in muscles. Vitamin C, vitamins B6 and Fe^{2+} are also necessary for its synthesis. The chains of fatty acids are bound to carnitin that facilitates their penetration through the membranes of mitochondrions, participates in oxidation, transmethylation and as a result it has a tyrosine effect. L-carnitin plays also an important role in the oxidation processes and in the transport of fatty acids (Szilagyi, 1998; Harmeyer, 2002,).

* Research was sponsored by the CMEPt No. 412 100 003.

MATERIAL AND METHODS

The aim of the study was to work out the analysis of the effect of substituting vegetable protein – soya for meat-bone meal on the achieved parameters of the fattening performance and carcass value in fattening final hybrid pigs.

The study included in total 72 hybrid pigs of the (LW_s x PN) x (LW_d x L) genotype at the age of 68 days of the total average live weight of 24.15 kg. The fattening period 91 lasted days. For the purpose of the testing of the substitution of meat-bone meal the pigs included in the test were divided into groups I and II.

Group I: 36 barrows and gilts with average live weight of 24.2 kg, fed with CFM with the use of meat-bone meal.

Group II: 36 barrows and gilts with average live weight of 24.1 kg, fed with CFM without the use of meat-bone meal.

The animals were penned according to the methods for tests of thoroughbred and hybrid pigs observing the principle of penning of animals in couples. Controlled feeding of CFM (complete feeding mixtures) was ensured by Duräumat self-feeders in several phases with a continuous transition. Feed compounds were mixed for each pen separately according to the feeding curve. Feed consumption was monitored for each couple and subsequently calculated per each individual animal. Pigs were prior to the inclusion in the test fed with a standard feed compound used for pigs prior to the fattening period.

In the laboratory of the Czech University of Agriculture there were permanently carried out analyses of the CFM. The complete feeding mixtures (CFM I / II) were fattened according to the following receptures and figures (Table 1).

In order to evaluate the fattening and growth performance the pigs were regularly weighed weekly and the following traits were observed:
- average live weight (ALW) during the fattening period in kg,
- feed conversion ratio (FCR) in kg,
- daily feed intake (DFI) in kg,
- protein intake (PI) in g,
- average daily gain (ADG) in g.

Starting from approximately 75 kg of average live weight of the tested pigs, also measurements were made at 7-day intervals of the MLLT area (mm^2) and height (mm), fat height (mm) including skin 7 cm para-medially from the spinal canal during the test and at its end by means of sonography using ALOKA SSD 500 – MICRUS device, namely between 2nd and 3rd last rib. Based on the acquired values the meatiness of hybrids was calculated, i.e. the carcass lean meat share by means of the regression equation designed for FOM equipment.

The data acquired from the test fattening was processed by standard mathematic-statistical methods, supplemented with polynomic curves and tables and figures.

Table 1. Ingredients and chemical composition of experimental diets

Nutrients of CFM I. – premix with meat-bone meal			
Components (%)	Feeding phase		
	up to 40 kg	45–60 kg	above 65 kg
Wheat	38.0	40.5	50.0
Barley	40.0	38.0	38.0
Soya extracted meal	14.2	10.5	3.0
Premix	7.8	11.0	9.0
Total	100	100	100
Nutrients in CFM	Feeding phase		
	up to 40 kg	45–60 kg	above 65 kg
Dry matter (g/kg)	882.2	881.1	880.7
Crude protein (g/kg)	176.8	164.8	138.0
ME (MJ/kg)	13.1	13.0	13.1
Crude fibre (g/kg)	31.6	36.9	37.1
Fat (g/kg)	23.3	24.1	24.3
Lysine (g/kg)	10.6	9.6	7.5
Threonine (g/kg)	6.9	5.8	4.5
Methionine (g/kg)	3.2	2.9	2.2
Ca (g/kg)	8.2	8.1	6.5
P (g/kg)	6.2	6.1	5.5
Nutrients of CFM II. – premix without meat-bone meal with soya substitution			
Components (%)	Feeding phase		
	up to 40 kg	45–60 kg	above 65 kg
Wheat	39.5	44.2	47.0
Barley	36.2	33.6	37.6
Soya extracted meal	20.3	17.1	9.0
Premix	4.0	5.1	6.4
Total	100	100	100
Nutrients in CFM	Feeding phase		
	up to 40 kg	45–60 kg	above 65 kg
Dry matter (g/kg)	880.0	879.5	878.3
Crude protein (g/kg)	174.7	165.0	138.7
ME (MJ/kg)	13.0	13.0	13.0
Crude fibre (g/kg)	29.0	31.3	36.8
Fat (g/kg)	16.7	17.4	18.7
Lysine (g/kg)	10.5	9.6	7.5
Threonine (g/kg)	6.8	5.8	4.6
Methionine (g/kg)	3.2	2.8	2.2
Ca (g/kg)	8.2	8.0	6.5
P (g/kg)	6.0	6.0	4.4

RESULTS AND DISCUSSION

The general evaluation of the fattening performance parameters of the monitored groups is documented by Table 2. The results show that both groups have achieved excellent parameters of the fattening performance. The average daily weight gain for the whole period of testing amounts in Group I to 921 g and in Group II to 917 g. The average daily intake of feed reached the same value

Table 2. General evaluation of the fattening performance of tested pigs according to the type of nutrition (n = 72)

Group	ALW (kg)		FCR (kg)		DFI (kg)		ADG (g)	
	$\bar{x} \pm s_{\bar{x}}$	s	$\bar{x} \pm s_{\bar{x}}$	s	$\bar{x} \pm s_{\bar{x}}$	s	$\bar{x} \pm s_{\bar{x}}$	s
I	106.0 ± 1.59	9.40	2.65 ± 0.04	0.25	2.43 ± 0.05	0.28	921 ± 16.95	100.26
II	106.2 ± 1.50	9.01	2.66 ± 0.04	0.22	2.43 ± 0.04	0.24	917 ± 15.67	94.00

Table 3. Evaluation of the fattening performance of tested pigs according to the type of nutrition (n = 72). Values of feed conversion ratio, daily intake of feed and weight gain are combined with polynomic curves

Group I (n = 36)					
Age (days)	ALW (kg)		FCR (kg)	DFI (kg)	ADG (g)
	$\bar{x} \pm s_{\bar{x}}$	s	$\bar{x}$	$\bar{x}$	$\bar{x}$
75	28.7 ± 0.56	3.34	1.72	1.43	832
82	34.8 ± 0.67	3.97	1.90	1.67	879
89	40.7 ± 0.72	4.24	2.06	1.89	917
96	47.1 ± 0.90	5.35	2.21	2.09	946
103	53.9 ± 0.96	5.67	2.34	2.26	967
110	61.3 ± 1.06	6.24	2.46	2.41	978
117	68.3 ± 1.11	6.58	2.58	2.53	980
124	74.8 ± 1.28	7.57	2.71	2.63	973
131	81.6 ± 1.42	8.37	2.83	2.71	957
138	88.1 ± 1.51	8.96	2.96	2.76	932
145	94.8 ± 1.53	9.07	3.11	2.79	898
152	100.9 ± 1.58	9.38	3.27	2.80	855
159	106.0 ± 1.59	9.40	3.46	2.78	803
Group II (n = 36)					
Age (days)	ALW (kg)		FCR (kg)	DFI (kg)	ADG (g)
	$\bar{x} \pm s_{\bar{x}}$	s	$\bar{x}$	$\bar{x}$	$\bar{x}$
75	29.1 ± 0.53	3.20	1.76	1.41	799
82	35.2 ± 0.70	4.20	1.93	1.66	858
89	41.3 ± 0.79	4.72	2.08	1.88	907
96	47.9 ± 0.85	5.12	2.21	2.08	944
103	54.8 ± 0.94	5.64	2.33	2.26	970
110	61.8 ± 0.98	5.85	2.45	2.41	985
117	68.7 ± 1.06	6.35	2.57	2.54	989
124	75.3 ± 1.13	6.75	2.69	2.64	982
131	82.3 ± 1.24	7.47	2.82	2.72	964
138	88.7 ± 1.35	8.11	2.96	2.77	935
145	95.2 ± 1.41	8.43	3.12	2.79	895
152	100.9 ± 1.52	9.15	3.31	2.80	844
159	106.2 ± 1.50	9.01	3.55	2.77	782

of 2.43 kg of CFM per day in feed and the feed conversion ratio in Group I was 2.65 kg of CFM per 1 kg weight gain and in Group II 2.66 kg. As a result it may be concluded that substituting the vegetable protein for animal protein had neither a significant impact on the intake of feed nor on the growth intensity, i.e. the average daily weight gain and the total feed conversion ratio (2.65 kg and 2.66 kg, respectively) which corresponds to O w e n et al. (2001), P i a o et al. (2000) and H e o et al. (2000).

Table 4. Evaluation of the formation of carcass lean meat in relation to the live weight of pigs, their age and type of nutrition (measured by Aloka-FOM)

Group I (n = 36)				
Age (days)	ALW (kg)		Lean meat share (%)	
	$\bar{x} \pm s_{\bar{x}}$	s	$\bar{x} \pm s_{\bar{x}}$	s
124	74.8 ± 1.28	7.57	57.6 ± 0.52	3.10
131	81.6 ± 1.42	8.37	59.2 a ± 0.70	4.13
138	88.1 ± 1.51	8.96	57.9 ± 0.64	3.76
145	94.8 ± 1.53	9.07	57.1 ± 0.55	3.24
152	100.9 ± 1.58	9.38	56.7 ± 0.62	3.65
159	106.0 ± 1.59	9.40	56.8 ± 0.64	3.79
Group II (n = 36)				
Age (days)	ALW (kg)		Lean meat share (%)	
	$\bar{x} \pm s_{\bar{x}}$	s	$\bar{x} \pm s_{\bar{x}}$	s
124	75.3 ± 1.13	6.75	57.1 ± 0.57	3.38
131	82.3 ± 1.24	7.47	57.2 a ± 0.62	3.70
138	88.7 ± 1.35	8.11	56.5 ± 0.59	3.55
145	95.2 ± 1.41	8.43	55.8 ± 0.58	3.46
152	100.9 ± 1.52	9.15	55.2 ± 0.66	3.95
159	106.2 ± 1.50	9.01	55.3 ± 0.64	3.84

$P < 0.05$ a

Table 3 and Figs 1a–c present the evaluation of the course of the studied parameters of the fattening performance where the identified phenotype values are combined with polynomic curves. The evaluation of the of the achieved average daily weight gain in the monitored groups revealed an almost identical trend when Group I achieved a statistically insignificant better growth mainly at the beginning and at the end of the period of testing. Thus on the basis of the intake of feed, i.e. DFI it may be stated that no differences were recorded between the two followed up groups throughout the whole course of the growth. The achieved values of FCR then logically developed in compliance with the above mentioned conclusions.

Evaluation of the course of the carcass lean meat formation in the tested pigs in relation to their live weight, age and type of nutrition is included in Table 4 and Fig. 2. The table documents that despite an almost identical weight achieved at regular intervals during the test in both monitored groups, a higher meat formation was found out in Group I as compared to Group II and the

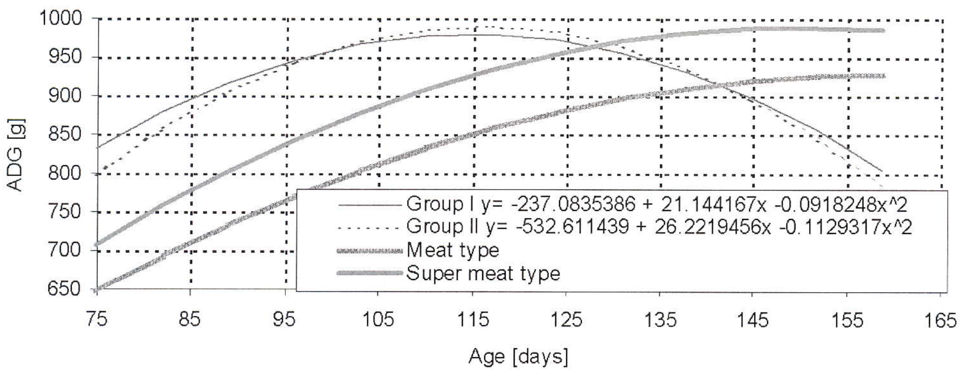

Fig. 1a. Evaluation of fattening capacity with respect to type of nutrition average daily gain (leaded by quadrat polynom)

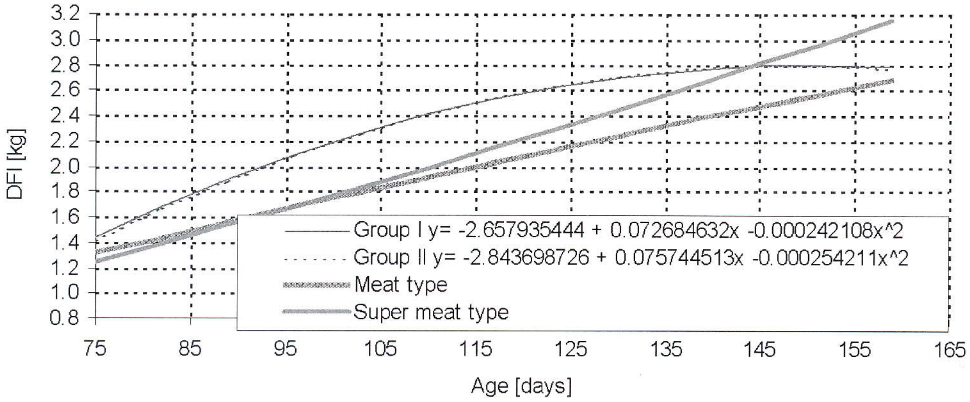

Fig. 1b. Evaluation of fattening capacity with respect to type of nutrition daily feed intake (leaded by quadrat polynom)

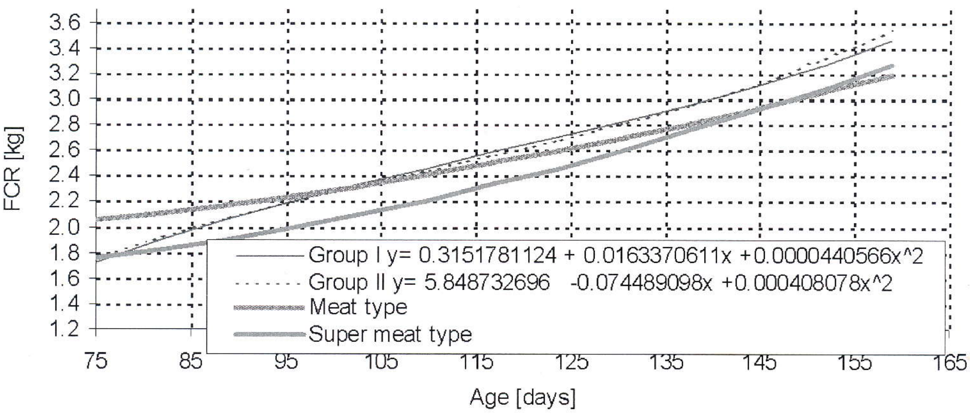

Fig. 1c. Evaluation of fattening capacity with respect to type of nutrition feed consumption ratio (leaded by quadrat polynom)

difference between the two groups represents in the course of the growth approximately 1.5% of meat. Therefore it may be concluded in accordance with Baumgartner, Blum (1997), Wang et al. (2000) that the animals fed with CFM without the animal protein achieve lower values of meat formation.

In order to better understand the above mentioned results, evaluation was made of MLLT formation (Table 5), namely between 2nd and 3rd last rib and the acquired values were used for the calculation of the meatiness of hybrids, i.e. carcass lean meat share, by means of regression equation designed for FOM equipment. The pigs fed with the animal protein achieved a greater loin eye area (Fig. 3a) and a higher MLLT height of meat (Fig. 3b). Significantly lower values of the height of fat were found out in the whole period of the growth of pigs (Fig. 3c). Based on these results it may be concluded that the pigs fed only with vegetable protein deposit more fat to the detriment of lean meat formation (Bachnudsen, Jorgensen, 1998; Heo et al. 2000).

The characteristics of the selected indicators of the fattening performance and meat formation with regard to the protein intake and type of nutrition is documented by Table 6 and Fig. 4. It is obvious that pigs of Group I had in the course of the test a higher intake of protein at individual monitored week intervals and reflected this increased intake in the higher meat formation in the carcass in agreement with Owen et al. (2001). Only in 10th week (at the age of 138 days) of the test, Group I recorded lower formation of lean meat as compared to Group II. The same trend was observed also in the efficiency of meat formation in relation to the crude protein received from CFM. Also in this respect Group I was

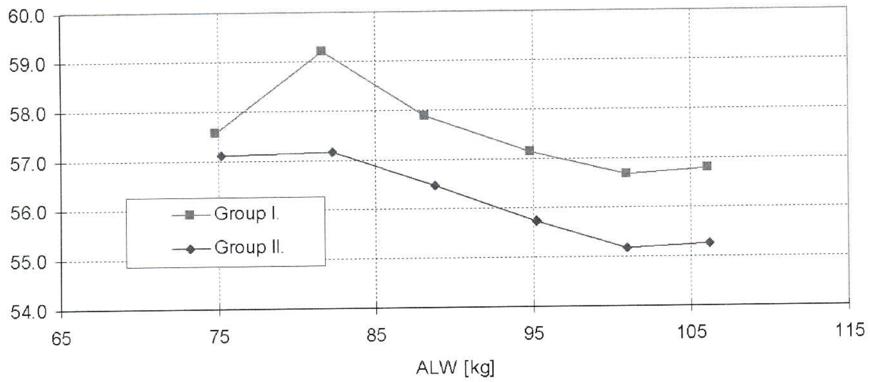

Fig. 2. Lean meat formation in the carcass with respect to body weight and type of nutrition

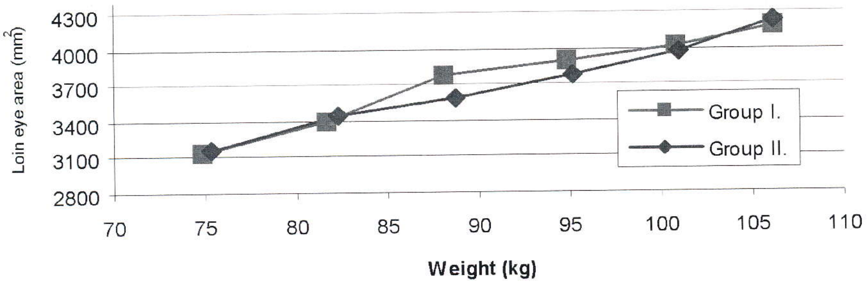

Fig. 3a. MLLT loin eye area formation

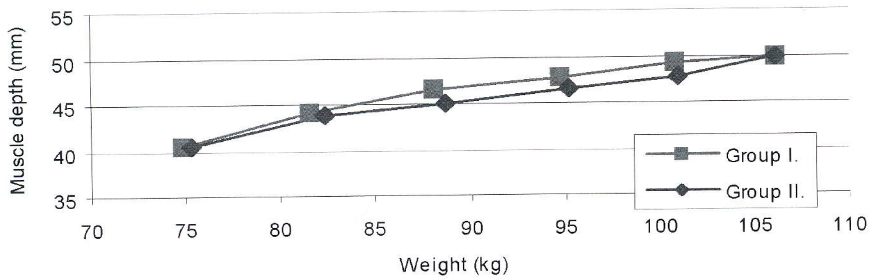

Fig. 3b. MLLT muscle depth formation

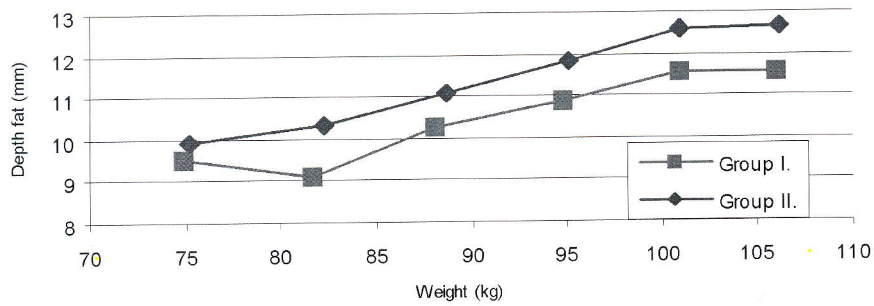

Fig. 3c. MLLT depth fat formation

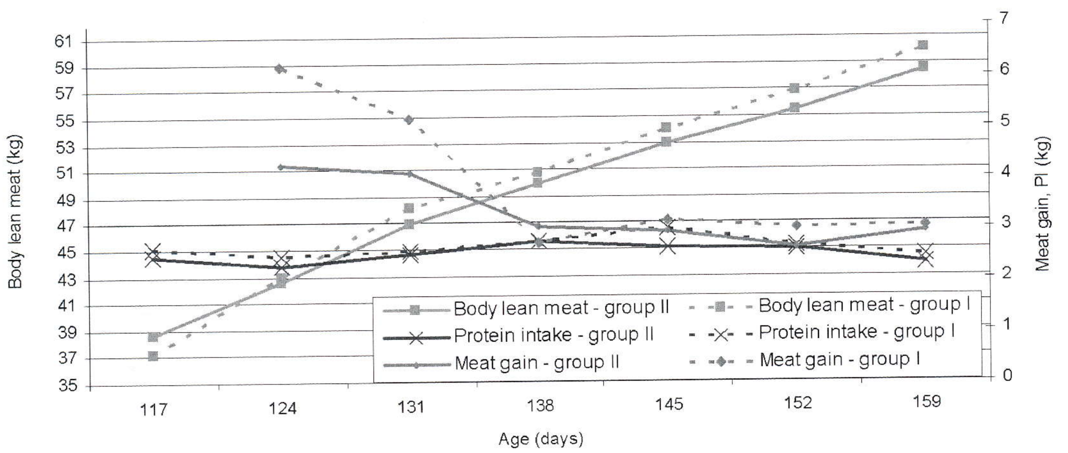

Fig. 4. Lean meat formation with respect to protein intake and type of nutrition – sum (n = 72)

Table 5. Characteristics of MLLT lean meat formation (detected by Aloka)

Week	ALW (kg)		Loin eye area (mm^2)		Muscle depth (mm)		Depth fat (mm)	
	$\bar{x} \pm s_{\bar{x}}$	s	$\bar{x} \pm s_{\bar{x}}$	s	$\bar{x} \pm s_{\bar{x}}$	s	$\bar{x} \pm s_{\bar{x}}$	s
Group I (n = 36)								
8	74.8 ± 1.28	7.57	3140 ± 52.97	313	40.4 ± 1.05	6.19	9.5 ± 0.39	2.28
9	81.6 ± 1.42	8.37	3409 ± 60.68	359	44.0 ± 0.61	3.58	9.1 ± 0.45	2.68
10	88.1 ± 1.51	8.96	3780 ± 56.57	335	46.5 ± 0.45	2.67	10.3 ± 0.47	2.78
11	94.8 ± 1.53	9.07	3895 ± 50.05	296	47.8 ± 0.46	2.71	10.9 ± 0.44	2.59
12	100.9 ± 1.58	9.38	4011 ± 57.75	342	49.1 ± 0.64	3.79	11.6 ± 0.51	3.04
13	106.0 ± 1.59	9.40	4176 ± 52.28	309	49.7 ± 0.60	3.53	11.6 ± 0.52	3.05
Group II (n = 36)								
8	75.3 ± 1.13	6.75	3153 ± 43.94	260	40.6 ± 0.38	2.27	9.9 ± 0.42	2.46
9	82.3 ± 1.24	7.47	3439 ± 46.50	279	43.7 ± 0.48	2.89	10.3 ± 0.44	2.67
10	88.7 ± 1.35	8.11	3581 ± 88.15	529	45.0 ± 0.63	3.76	11.1 ± 0.48	2.91
11	95.2 ± 1.41	8.43	3775 ± 58.43	351	46.4 ± 0.54	3.23	11.8 ± 0.48	2.87
12	100.9 ± 1.52	9.15	3968 ± 56.38	338	47.8 ± 0.58	3.49	12.6 ± 0.53	3.16
13	106.2 ± 1.50	9.01	4238 ± 55.30	332	49.8 ± 0.64	3.84	12.6 ± 0.53	3.15

Table 6. Fattening performance and efficiency of lean meat formation with regard to the type of nutrition

Week	Age (days)	ALW (kg)	ADG (g)	PI (kg/week/pig)	Lean meat share (%)	Meat (kg)	Meat formation (kg)	Effectivity
Group I (n = 36)								
7	117	68.3	1002	2.64	54.0	37.2		
8	124	74.8	931	2.47	57.6	43.0	6.2	2.50
9	131	81.6	967	2.58	59.2	48.1	5.1	2.00
10	138	88.1	930	2.74	57.9	50.8	2.7	0.99
11	145	94.8	957	3.00	57.1	54.0	3.2	1.06
12	152	100.9	869	2.66	56.7	57.0	3.0	1.12
13	159	106.0	738	2.46	56.8	60.0	3.0	1.23
Group II (n = 36)								
7	117	68.7	990	2.46	56.2	38.6		
8	124	75.3	939	2.29	57.1	42.6	4.2	1.85
9	131	82.3	1000	2.50	57.2	46.9	4.1	1.64
10	138	88.7	927	2.74	56.5	50.0	3.0	1.11
11	145	95.2	921	2.63	55.7	52.9	2.9	1.12
12	152	100.9	823	2.58	55.2	55.5	2.6	1.01
13	159	106.2	744	2.32	55.3	58.5	2.9	1.26

achieving, with the exception of 10th week, higher values throughout the whole period of testing.

CONCLUSION

- Substituting the vegetable protein for animal protein had neither any significant impact on the intake of feed nor on the growth intensity, i.e. the average daily weight gain and feeding conversion.
- The animals fed with CFM without animal protein achieve lower values of meat formation, the pigs fed with animal protein achieved a greater area and a higher height of the MLLT lean meat, and significantly lower values of the height of the back fat were found out in the whole course of the growth of pigs.
- The pigs fed only with the vegetable protein deposit more fat to the detriment of lean meat formation.
- The animals feed with CFM with the animal protein had in the course of the test a higher intake of crude protein at individual monitored week intervals and reflected this increased intake in the higher meat formation in the carcass.

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Received for publication on October 5, 2005
Accepted for publication on November 16, 2005

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Efekt náhrady masokostní moučky sójou na vybrané parametry výkrmnosti a jatečné hodnoty u rostoucích hybridních prasat.

Scientia Agric. Bohem., *37*, 2006: 108–114.

Cílem práce bylo provést analýzu vlivu náhrady masokostní moučky rostlinnou bílkovinou – sójou – na vybrané parametry výkrmnosti a jatečné hodnoty při výkrmu finálních hybridů prasat. Do sledování bylo zařazeno 72 prasat hybridní kombinace křížení otec – matka (BO x PN) x (BU x L) ve věku 68 dnů o celkové průměrné živé hmotnosti 24,15 kg vyrovnaného pohlaví.

Bylo zjištěno, že náhrada živočišné bílkoviny rostlinnou nemá prakticky žádný vliv na příjem krmiva a ani nebyl prokázán vliv na růstovou intenzitu, tedy na dosažený průměrný denní přírůstek (921 g, resp. 914 g). Zvířata krmená kompletní krmnou směsí bez živočišné bílkoviny dosahovala nižších hodnot tvorby masa (56,8 %, resp. 55,3 %) a ukládala více tuku na úkor svaloviny.

Naopak prasata krmená živočišnou bílkovinou dosahovala vyššího podílu masa, větší plochy, vyšší výšky svalu *musculus longissimus lumborum et thoracis* (MLLT) a výrazně nižší výšky hřbetního tuku (11,6 mm, resp. 12,6 mm) po celou dobu růstu. Dále měla během testu v jednotlivých sledovaných týdenních intervalech vyšší příjem NL, přičemž tento zvýšený příjem se promítl do vyšší tvorby masa v jatečných tělech.

prase; výživa; výkrmnost; jatečná hodnota.

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