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DO HIGHER LEVELS OF AVAILABLE PHOSPHORUS AND CALCIUM AT DIFFERENT PROTEIN DIETS INFLUENCE THE PERFORMANCE IN GROWING PIGS?

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ABSTRACT

One trial comprising 52 Danube White pigs in total spread over four groups (7 males and 6 females in each group) was carried out in Agricultural Institute, Shumen. The live weight of the animals at the start of the experiment (when pigs were 45-days old) was around 9.8 kg and at the end of the experiment (when pigs were 110 days old) 33-36 kg. The aim of this study was to test the effect of two levels of available P (0.35% and 0.80%) and Ca (0.71% and 1.22%) at two protein levels (18% and 16 %, respectively) in diets on the productivity of growing pigs. The following conclusions were made: increase in the level of available P from 0.34%-0.35% to 0.80% and level of Ca from 0.71% to 1.22% in compound feeds for pigs (having 9.7-9.9 kg to 33.0-36.0 kg LW) LW had no effect on feed intake, average daily gain (ADG) and feed conversion ratio (FCR). Higher growing rate and lower FCR had been established in pigs with higher protein feed intake (18% *vs.* 16% at $P<0.05$). In this experiment the effect of protein was highly significant and had higher impact on pig's growing rate than the levels of P and Ca (at equal Ca/P ratio).

Key words: growing pigs; protein; available phosphorus; calcium; ADG; FCR

INTRODUCTION

The period of growing in pigs is connected not only to a process of intensive formation of bones but also with accumulation of muscle tissue (Doige et al., 1975; Pond et al., 1975). For good development of a bone structure young pig's organism is needed a proper adjustment of Ca and P levels in diets. Optimum requirements for protein and phosphorous levels in growing pigs have been studied by many authors in different countries (Mircheva et al., 1989; Nonn and Franke, 1998; Skiba et al., 2001; Traylor et al., 2001; Weremko et al., 2001). Jongbloed (1987) reported that higher protein level in diets requires higher phosphorus level.

In previous studies (Nedeva, 2002; Nedeva and Kanev, 1993), we reported that the ratio of the Ca and P between 1.1:1 to 1.3:1 does not substantially influence the productive traits (level of growing rate and feed conversion ratio) in growing pigs. Manipulation of diet in Ca and available P contents is connected not only with normal growing rate and health status of the animals but also with decrease in phosphorous pollution. Some other studies (Ivanova-Peneva and Nedeva, 2006) showed protein level in diets could be decreased for reduction of excessive amount of nitrogen being excreted by pigs.

The aim of this study was to test the effect of two levels of available P and Ca at two protein levels in diets on the productivity of growing pigs.

MATERIALS AND METHODS

One trial comprising 52 Danube White pigs in total spread over four groups (7 males and 6 females in each group) was carried out in Agricultural institute, Shumen. Animals were aligned according to number in a group, live weight, sex, age and age of weaning (45 days). The live weight of the animals at the start of the experiment was 9.7 – 9.9 kg and at the end of the experiment (when

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pigs were 110 days old) 33.1 – 35.8 kg.

The composition of diet, nutrients and energy content per kg compound feed has been presented in Table 1. The diet protein level was same for group I and II, and again for group III and IV, the difference between these two sets being 2 units. The levels of available P and Ca were was same in grous I and III, and again in groups II and IV. Calcium-phosphorous ratio was kept constant in all groups. Group I had 18% protein, 0.71% Ca and 0.35% available P; group II had 18% protein, 1.22% Ca and 0.80% available P; group III had 16% protein, 0.71% Ca and 0.35% available P and group IV had 16% protein, 1.22% Ca and 0.80% available P. The different levels of proteins were obtained by different percentage inclusions of soybean meal in the diets of different groups. The different calcium and phosphorus levels were obtained by different percentage inclusions of limestone or dicalcium phosphate.

Pigs were raised individually and fed *ad libitum* with dry feed. The contents of water, dry matter, protein, fats, fibres, minerals, Ca and P in feed were analysed in advance. Digestive and metabolizable energy contents were calculated according to values of digestible nutrients in our previous experiments and the equations of Beyer (1974) and Nerring (1976). Water was made available *ad libitum* from nipple drinkers. Pig's live weight was controlled every fourteen days. The data were analyzed according to the methods of two-factor analyses of variance. One factor was the protein level and the other was P-content of the feed. The group was the treatment. Least square means, their valuations and standard errors of difference of the indices was measred according to Hinkovski *et al.* (1984). Pearson's correlation coefficients and regression coefficients between protein intake, Ca intake, P intake, ADG and FCR were calculated.

Table 1: Composition of diet, nutrients, and energy content per kg compound feed for growing pigs (in original matter)

Component, %	Group			
	I	II	III	IV
Maize	21.45	16.10	27.35	24,00
Wheat	24.00	24.00	23.00	22.00
Barley	25.00	28.00	25.30	25.50
Wheat bran	8.00	8.00	8.00	9.50
Soy-bean meal	17.00	17.00	11.00	11.50
Fish meal	2.50	2.50	2.50	2.40
Lysine	-	-	1.10	0.95
Premix	1.0	1.00	1.00	1.00
Trace minerals mixture	0.10	0.10	0.10	0.10
Limestone	0.40	0.30	-	-
Dicalcium phosphate	0.35	2.80	0.45	2.85
Salt	0.20	0.20	0.20	0.20
Total	100.00	100.00	100.00	100.00
Digestible energy, kcal	3054	3162	3202	3131
MJ	12.78	13.23	13.40	13.10
Metabolizable energy, kcal	2918	3027	3080	3008
MJ	12.21	12.67	12.89	12.59
Crude protein, g	179.4	179.3	160.3	1602
g/MJ ME	14.69	14.5	12.44	12.72
Lysine, g	8.2	8.3	8.0	7.9
g/MJ ME	0.67	0.66	0.62	0.63
g/100g protein	4.57	4.63	4.99	4.93
Methionine + cysteine, g	6.5	6.5	5.8	5.8
Tryptophan, g	2.3	2.3	1.9	2.0
Threonine, g	6.6	6.6	5.6	5.6
Calcium, g	7.1	12.2	7.1	12.2
Phosphorus, g	6.0	10.4	6.0	10.3
Available phosphorus, g	3.4	8.0	3.5	8.0
Calcium/Available phosphorus	2.09	1.53	2.03	1.53

Table 2: Live weight, feed intake and feed conversion ratio in growing pigs

Trait	18% protein				16% protein			
	0.71% Ca, 0.34% P*		1.22% Ca, 0.80% P*		0.71% Ca, 0.35% P*		1.22% Ca, 0.80% P*	
	$\bar{x}$	$S_{\bar{x}}$	$\bar{x}$	$S_{\bar{x}}$	$\bar{x}$	$S_{\bar{x}}$	$\bar{x}$	$S_{\bar{x}}$
Live weight initial, kg	9.727	0.245	9.892	0.249	9.936	0.251	9.834	0.227
Live weight final, kg	35.818	0.757	35.317	0.794	33.127	0.820	34.523	0.719
Feed intake per capita per day, kg	1.037	0.015	1.049	0.017	1.031	0.015	1.035	0.012
Protein intake, g	186.0cd	2.736	188.0ef	3.106	165.3ce	2.388	165.8df	1.880
Calcium intake, g	7.4cd	0.113	12.8ce	0.208	7.3ef	0.106	12.6df	0.143
Total phosphorus intake, g	6.2cd	0.091	10.9ce	0.179	6.2ef	0.089	10.7df	0.120
Total available phosphorus intake, g	3.6	0.055	8.5	0.144	3.6	0.056	8.7	0.098
FCR of protein, g	465.6	8.809	483.0	9.513	467.1	13.572	439.4	9.157
FCR of calcium, g	18.4 cdm	0.349	32.9ce	0.647	20.7efm	0.598	33,.5df	0.697
FCR of total phosphorus, g	15.6cdm	0.301	28.0ce	0.550	17.5efm	0.512	28.2df	0.587
FCR of available phosphorus, g	8.8	0.162	21.8	0.426	10.2	0.290	23.0	0.482

P* - digestible phosphorus; c,d,e,f – $P < 0.001$, m - $P < 0.01$

RESULTS AND DISCUSSION

Animals from different groups had practically equal compound feed intake (table 2). Pigs from group III and group IV had lower (11% and 12%, respectively) protein intake in comparison to pigs from group I and group II ($P<0.001$). The ration levels of the available P and Ca di ndot influence feed intake in all treatments. This was the reason the available P and Ca intake in groups II and IV was higher than in groups I and III. The differences between groups were highly significant ($P<0.001$).

Protein conversion ratio per kg ADG was the lowest in pigs from group IV. The difference between group IV and group II was 9% ($P<0.01$) and 6% between group IV and groups I and III, but statistically non-significant. Ca and available P conversion ratios per kg ADG were higher and statistically significant in groups II and IV (pigs with higher levels of both elements in feed).

The data from LS-analyses (table 3) showed that pigs from group I had higher positive and statistically significant ($P<0.01$) valuations of the ADG (401 g), followed by those of group II ($P<0.05$). The lowest negative and statistically significant valuations of the ADG were noted in pigs from group III. These results confirm recommendations of Jongbloed (2008) who suggested 3.4% digestible phosphorus in diets of growing pigs. An the same time, our results were not in agreement with those of Reinhart *et al.* (1976), who had established improved ADG and feed intake in pigs with 20 kg LW with increasing available P and Ca levels in the diets.

Table 3: LS-valuations for effect of treatment on ADG in growing pigs

Group	Protein, %	Ca, %	Available P, %	ADG (g) $\bar{x}$	a*	SE	*P* value
1	18	0.7	0.34	401	19.161	13.251	1-3 – $P<0.01$ 2-3 - $P<0.05$
2	18	1.2	0.80	391	8.964	13.056	
3	16	0.7	0.35	357	-25.384	13.251	
4	16	1.2	0.80	379	-2.741	12.888	
Total LS-average					382	10.672	

a* - LS valuations, which is the difference from the mean according to the treatment

Table 4: LS-valuations for effect of treatment on FCR in growing pigs

Group	Protein, %	Ca, %	Available P, %	FCR (kg) $\bar{x}$	a*	SE	*P* value
1	18	0.7	0.34	2.595	-0.141	0.077	1-3 – $P<0.001$ 2-3 - $P<0.05$
2	18	1.2	0.80	2.694	-0.043	0.076	
3	16	0.7	0.35	2.914	0.177	0.077	
4	16	1.2	0.80	2.743	0.007	0.075	
Total LS-average					2.736	0.062	

a* - LS valuations, which is the difference from the mean according to the treatment

The results from table 4 showed the lowest negative and statistically significant valuations of FCR in pigs from group I (P<0.001), followed by those of group II (P<0.001). The highest positive and statistically significant valuations of FCR were found in pigs from group III. The difference was statistically significant in comparison to group I (P<0.001) and group II (P<0.05). In fact, these values of feed conversion ratio showed the best performance by pigs from group I, receiving higher level of protein with lower levels of Ca and P, followed by group II, also with higher level of protein. But, the lower level of available phosphorus in the diets of groups I and III pigs (0.34 and 0.35 gkg^{-1}) in comparison to groups II and IV (0.8 gkg^{-1}) did not affect FCR, as reported by Hinson et al. (2009) in experiments with nursery and growing pigs.

Table 5: F-criterion of the traits ADG and FCR in growing pigs

Sources of variance	ADG	FCR
Protein	P<0.05	P<0.05
Available phosphorus	n.s.	n.s.
Calcium	n.s.	n.s.

The analyses of variance (table 5) also showed that the protein level had the most and statistically significant effect (P<0.05) on ADG and FCR. The available P and Ca levels did not influence these traits significantly. These results indicated that in the early growing period pigs had been tolerant to higher levels of Ca (1.22 %) and available P (0.80%), when keeping Ca/P ratio 1.17 – 1.18:1. Our results are in unison with those of Nicodemo et al. (1998), which reported that the productivity of growing pigs did not decrease while keeping the Ca/P ration of 1.3:1 for both the elements at high levels as observed in in group II. The same trend was established by Nietro et al. (2008). They found that growing rate and protein deposition in growing Iberian pigs remained unaffected by the level of Ca and P. All these findings are in contradiction to conclusions of Kanakov (2005), who established negative effect of decreasing P level on productivity of pigs. The low-phosphorus diet gave significantly poorer results than the phosphorus-rich diet; while there were no beneficial effects of supplementing phosphorus at a level higher than 2.4 g/kg.

The calculated correlation coefficients between protein intake and ADG (table 6; r_p = 0.604 at P<0.001) and between protein intake and FCR (r_p = -0.336 at P<0.05) confirmed the limited dependence of the productivity of pigs on feed protein levels. The calculated correlation coefficients between the available P and Ca intake and ADG and between the available P and Ca intake and FCR had lower values and were statistically non-significant.

CONCLUSIONS

Increase in the level of available P from 0.34%-0.35% to 0.80% and the level of Ca from 0.71% to 1.22% in compound feeds for pigs with 9.7-9.9 kg to 33.0-36.0 kg LW had no effect on feed intake, ADG and FCR.

Higher growing rate and lower FCR had been established in pigs with higher protein feed intake (18% *vs*. 16%; P<0.05).

In this experiment the effect of protein was highly significant and had higher impact on growth rate of pigs rather than the levels of P and Ca (at equal Ca/P ratio).

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Table 6: Correlation (1) and regression (2) coefficients of some traits

Regression coefficient (R_{xy})	Correlation coefficient (r_p)				
	Protein intake	Calcium intake	Available phosphorus intake	ADG	FCR
Protein intake	-	0.159	0.169	0.604***	-0.336*
Calcium intake	0.796	-	1.000***	0.176	-0.091
Available phosphorus intake	0.992	1.178	-	0.176	-0.092
ADG	214.131	12.460	10.633	-	-0.874***
FCR	-19.748	-1.066	-0.914	-0.145	-

Notice: (1) – above the diagonal; (2) – bellow the diagonal

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