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Nutrition and Physiology

Effect of dietary amino acid concentration on nitrogen balance in PIC hybrid pigs

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Abstract. *A balance trial was performed with 3 groups of three PIC hybrid pigs each fed 3 dietary levels of digestible amino acids – 85 %, 100 % and 115 % of standrd. The control group was fed according to nutrition standards (100 %). The other two groups, received a ration with amino acid content lower or higher by 15%, respectively, compared to controls. The nutrition standards for digestible amino acid content of feeds for the PIC hybrid are perfectly adequate to the needs of animals. They allowed a daily retention of 25 g N and a relatively good utilization of feed protein. The digestible amino acid excess did not improve the nitrogen retention, but only increased its excretion with urine. The water intake and the amount of excreted urine of pigs were directly related to the dietary nitrogen concentration. They were found to increase parallelly to dietary digestible amino acids content.*

Keywords: N balance, levels of digestible amino acids, PIC hybrid pigs, N retention and excretion

Introduction

The contemporary pig hybrids possess a high potential for feed utilization due to the lower fat tissue growth rate and the higher lean growth rate compared to old genotypes. These animals, however require a higher dietary protein and amino acid levels, that could not always utilized efficiently (Kornegay and Verstegen, 2001; Sutton, 2008.). Non-utilized nitrogen compounds are excretes with faces and are a factor of environmental pollution. It is established that about 15-18 % of dietary nitrogen intake is excreted with faeces and about 50% - with urine (mainly under the form of urea) (Jongbloed and Lenis ,1992; Ferket, 2002). Therefore, the total nitrogen output in pig industry amount to about 65% of dietary nitrogen intake (Jongbloed and Lenis, 1992; Canh et al., 1998; Ferket, 2002; van Heugten and van Kempen, 2000). This amount could be significantly changed with altering dietary protein levels and amino acid digestibility (van Heugten et al., 2001; Kornegay and Verstegen, 2001; Ferket, 2002; Sutton, 2008). The nitrogen output with excreta could be optimized by ensuring a proper balance between dietary amino acid content and the needs of animals for maintenance and growth.

During the last years, synthetic amino acids are increasingly used to balance pig diets. It was experimentally shown that pigs weighing 15 kg fed synthetic amino acids as sole protein source, could utilize 87% of nitrogen intake for maintenance and body protein synthesis (Simpson, 2004). Under industrial conditions, the use of synthetic amino acids in diets allowed to satisfy the needs of animals without excesses as when rations are balanced with natural protein feeds. Such nutrition ensures low nitrogen consumption and reflects on the overall nitrogen excretion (Canh et al., 1998; Reese, 2004; Sutton, 2008). It is established that the nitrogen output decreased by 8% to 11% with each percent of dietary nitrogen reduction (Schutte et al., 1993; Monge et al., 1998; Sutton, 2003; Reese, 2004).

According to Otto et al. (2003) the good balance of dietary amino acids as per animals' needs could reduce the output of N in manure by 35% during the grower and by 20% during the finisher period without affecting the growth rate of pigs. Yamamoto (2002) observed that the lower dietary crude protein level and ration balancing with synthetic amino acids could decreased nitrogen output in urine and faeces by 50% and 28%, respectively. This resulted in reduction of the total nitrogen output with 38 %. Similar results were reported by Sutton et al. (1997), Sutton, (2003), Le et al. (2005), O'Connell et al. (2006). The lower dietary protein amount with using synthetic amino acids reflected upon water consumption and the amount of urine (Prince et al., 2000; Shaw et al., 2006; Schiavon and Emmans, 2000). The total aromatic components were also strongly reduced (Sutton et al., 1997; Richert and Sutton, 2006; Sutton, 2008).

Dietary protein level depends mainly on the genotype and the age of animals. Modern porcine hybrids, not only require high dietary nitrogen concentrations, but also a strict ratio between the different essential amino acids (Crocker and Robison, 2002). Every deviation from the real needs of animals results in poor economical results (Kerr and Easter, 1995; Figueroa et al., 2002; Crocker and Robison, 2002).

The PIC hybrid is reared in Bulgaria since 2004. The population is relatively small. The sows are of the Camberow 23 line, and sires – terminal males of line 477 (Stoykov et al., 2007; Stoykov and Katsarov, 2010). Until now, there are no investigations determining the effect of dietary amino acid level upon nitrogen retention and excretion in this hybrid.

The present study aimed to investigate the influence of different digestible amino acid levels in compound feeds on nitrogen balance in finisher PIC hybrid pigs.

Material and methods

A balance trial was performed with three groups of three PIC hybrid pigs each. The experiment's duration was 10 days, 5 days

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preliminary and 5 days experimental period. Castrated male pigs with average live body weight of 80 kg were used. They were reared in individual metabolic cages facilitating the separate collection of urine and faeces.

Feeds and nutrition

Animals were fed complete compound feeds that, for control group, were compliant to PIC Nutrient Specifications (2008). In pigs from the first group, dietary digestible amino acids were reduced by 15 % compared to controls, and in those from the third group – increased by 15 % (Table 1). During the experiment, the animals received feed *ad libitum*. Feed was offered twice – at 8.30 AM and 4.30 PM. The remainder was gathered every day prior to the morning feeding. Water was given in ordinary troughs allowing a free access to drinking water. The ambient temperature in the premise where the pigs were kept was maintained within the thermal comfort range.

Determination of output

Faeces were collected in the morning prior to feed offering. Two samples were collected for analysis on a daily basis. The first (5% from the total amount) was utilized for determination of nitrogen content in fresh faeces, and the second (10% from the total amount) was dried at 60-65 ^{0}C in a dryer. Fresh faeces were kept in freezers at -17 ^{0}C until analyzed. By the end of the trial, samples from each animal were combined and after a thorough homogenization, a pooled sample was taken for analysis. Dried faeces of each pig were collected in individual polyethylene bags. At the end of the experiment, they were milled on a laboratory mill with 1mm sieve openings and a pooled sample was taken for analysis.

Excreted urine was collected in plastic containers with 100-200 ml 10% H2SO4 (about 5% of urine amount). The urine volume was measured every morning and 10% was retained for analysis. Urine samples from each pig were collected in individual plastic bottles and stored in a refrigerator until analyzed.

Analyses

All samples were run in duplicate. The total nitrogen content in feeds, faeces and urine were assayed as per AOAC (2007). Data about feed and water consumption, amounts of faeces and urine, nitrogen retention and output were calculated. Statistical analysis was performed with Statistica 6 software.

Table 1. Ingredients content and nutritive value of used compound feeds fficients of linear discrete models

	Level of CP			1 kg compound feed contains			
					Level of CP		
Ingredients, %	85%	100%	115%	Parameters	85%	100%	115%
Corn	27.32	17.91	14.70	ME MJ/kg	13.00	13.07	13.00
Wheat	20.00	20.00	15.00	CP, %	12.00	13.70	15.30
Barley	40.00	40.00	40.00	Total amino acids, %			
Soybean meal	3.00	6.00	9.50	Lysine	0.63	0.73	0.83
Sunflower meal	3.00	6.00	8.00	Methionine	0.23	0.27	0.32
Wheat bran	2.00	4.00	6.00	Methionine + Cystine	0.48	0.55	0.62
Sunflower oil	1.30	2.80	3.50	Threonine	0.42	0.48	0.55
L - Lysine	0.30	0.30	0.30	Tryptophan	0.28	0.27	0.27
DL - Methionine	-	-	-	Digestible amino acids, %			
L - Threonine	0.08	0.09	0.10	Lysine	0.55	0.65	0.74
Salt	0.30	0.30	0.30	Methionine	0.20	0.24	0.28
Limestone	0.80	0.80	0.80	Methionine + Cystine	0.37	0.42	0.46
Dicalcium phosphate	1.40	1.30	1.30	Threonine	0.35	0.41	0.46
Vitamin premix	0.50	0.50	0.50	Tryptophan	0.20	0.21	0.21
Total	100.0	100.0	100.0	Ca, %	0.68	0.69	0.69
				P available, %	0.28	0.28	0.28

Results and discussion

The digestive amino acid levels in rations had no effect on feed consumption and the amount of faeces (Table 2). The water intake increased parallelly to increase in dietary amino acids. Per one kg feed intake, the pigs drank on the average 2.1 l water. The amount was lower than the nutrient recommendations for this category pigs. Pigs from the third groups drank significantly more water than the other two groups. It could be attributed to the need for elimination of the excessive nitrogen from the body of pigs. According to NRC (1998) when protein intake of animals is high, the excess is degraded and excreted as urea. This process requires additional amount of water. A close relationship between excessive dietary protein in animal feeds and the water intake was established (Simpson, 2004; Ilchev et al., 2008a). It could be therefore assumed that dietary nitrogen content for the third group of pigs was higher than that needed for maintenance and for growth. The urine output also supported this hypothesis. The amount of excreted urine increased significantly ($P<0.05$) with higher dietary protein levels.

The dietary level of digestible amino acids (Table 3) had a significant impact on nitrogen intake, which increased parallelly with dietary protein ($P < 0.05$). he faecal nitrogen output varied between 15 and 20 % of dietary intake and did not differ from what was reported in previous studies. As absolute values however, there was a tendency towards higher nitrogen output with faeces when dietary N increased. The differences between groups I and III were statistically significant ($P<0.05$). Similar results in an experiment with growing pigs were reported by Yamamoto et al. (2002). Dietary amino acid content did not influence nitrogen digestibility that was

Table 2. Feed and water intake and amounts of excreted faeces and urine during the feed balance trial

Parameters	Groups		
	I (85%) Mean±SE	II (100%) Mean ± SE	III (115%) Mean±SE
Feed intake, kg/day	2.85±0.03	2.85±0.07	2.80±0,007
Water intake, l/day	4.80±0.34[a]	5.36±0.25[b]	7.61±0.43[ab]
Faeces, kg/ day	1.48±0.14	1.35±0.22	1.48±0.10
Urine, l/ day	1.85±0.07[a]	2.53±0.28[a]	3.51±0.02[a]

a,b - equal letters designate statistically significant differences

Table 3. Nitrogen balance

Parameters	Groups		
	I (85%) Mean±SE	II (100%) Mean±SE	III (115%) Mean±SE
Intake N, g/day	54,40±0,71[a]	62.08±1.52[a]	68.09±0.31[a]
Fecal N, g/ day	9,83±0,34[a]	9.75±0.25[b]	11.38±0.31[ab]
Digestibility N, %	81,93±0,58[a]	84.29±0.24[a]	83.29±0.28
Urinary N, g/ day	23,17±0,49[a]	27.38±0.95	31.19±2.24[a]
Total excreted N, g/ day	33,01±0,83[a]	37.13±1.20	42.56±2.55[a]
Retened N, g/ day	21,40±0,27[ab]	24.95±0.57[a]	25.52±1.38[b]
Retention N, %	39,35±0,82	40.21±0.74	37.57±2.50

a,b - equal letters designate statistically significant differences

established at 83% on the average in the present experiment. Similar results were reported Gatel and Grosjean (1992).

The differences between groups with regard to urine nitrogen output and the total nitrogen output were significant. They increased parallelly to dietary amino acids (P<0.05). Thus, it was once again confirmed that dietary nitrogen content for the third group of pigs was higher than animals could utilize.

Nitrogen retention is a primary parameter for finisher pigs (Figure 1). The results of the present experiment have shown that the retention of pigs from groups II and III was almost equal – about

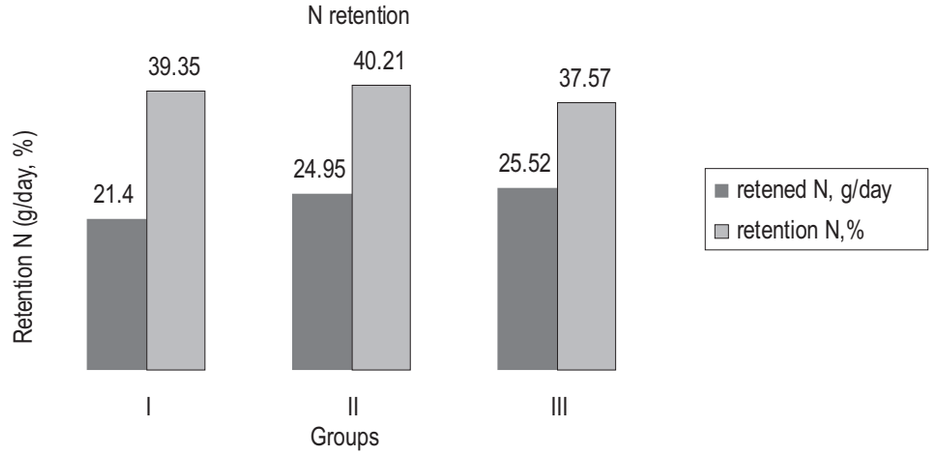

Figure 1. N retention

25 g/day. This level is considered as optimal for pigs from contemporary genotypes during the finisher stage (Schriftenreihe Warenteste – 29). The lack of inter-group differences showed that most probably, a retention threshold for this stage of hybrid's development was attained. Therefore the requirements for digestible amino acids for the PIC hybrid reflect exactly the needs of animals. The increased by 15% did not influence the nitrogen retention, but only increased nitrogen output. On the other hand, the reduction of dietary amino acids by 15% had an adverse effect on body protein. Pigs from the first groups exhibited lower nitrogen retention by 16.6% and 19.3% compared to group II and III, respectively. The utilization of nitrogen (about 40 %) is normal for this

stage of finisher pigs' development. Lower results obtained with pigs from experimental groups compared to control pigs could be, in our view, due to dietary amino acid deficiency (in the first group) or excess (in the third group) that could not be properly utilized.

Conclusion

The nutrition standards for digestible amino acid content of feeds for the PIC hybrid are perfectly adequate to the needs of animals. They allowed a daily retention of 25 g N and a relatively good utilization of feed protein. The digestible amino acid excess did not improve the nitrogen retention, but only increased its excretion with urine. The water intake and the amount of excreted urine of pigs were directly related to the dietary nitrogen concentration. They were found to increase parallelly to dietary digestible amino acids content.

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