Optimal standardised ileal digestible lysine level in hybrid meat pigs (70-110 kg)

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Introduction

In cost-effective and efficient pig husbandry, pigs are fed according to their needs, which implies a compromise between maximal animal performance, minimal nutrient losses and low feed costs. This necessitates that the pig's response in terms of animal performance on increasing dietary amino acid levels is known. Therefore, the essential amino acid requirements for optimal animal performance were determined in this study within the weight range of 70 to 110 kg for barrows and gilts separately. In earlier experiments, the lysine requirement was investigated for the weight ranges 8-25 kg (Warnants et al., 2001), 25-45 kg (Warnants et al., 2002) and 40-70 kg (Warnants et al., 2003). The study was conducted as a dose-response model, with the doses being the levels of dietary ideal protein, represented by lysine (Lys) levels, and the response was either average daily gain (ADG) or feed conversion ratio (FCR). Besides the animal performance trial, a digestibility trial with fistulated pigs was executed to determine the ileal digestible amino acid contents. Requirements in literature often refer to another type of pig, sometimes with lower meat percentage and faster growth. Moreover, the way of expressing amino acid requirements also changed from total over apparent ileal digestible to standardised ileal digestible (SID) units. The term standardised ileal digestibility implies the measurement of the digested amino acids at the end of the ileum while taking the non feed-dependent endogenous amino acid secretions into account.

Materials and methods

Six isoenergetic (9.2 MJ/kg) diets were formulated, according to the ideal protein concept (Baker et al., 1993), with the following analysed Lys-levels: 0.55, 0.67, 0.80, 0.92, 1.05 and 1.17%; crude protein levels ranged from 10 till 20%. Diets were based on cereals and soybean meal. The feeds were prepared by mixing the lowest and highest Lys-level feeds in the following proportions: 0/100, 20/80, 40/60, 60/40, 80/20 and 100/0. Diets were analysed for their proximate composition and amino acids. The performance trial consisted of 11 series of 5 pigs per diet and per sex or 660 pigs in total. All pigs were from a Piétrain boar x Hybrid dam cross and were housed per 5 and per sex. Feed and water were available unrestrictedly. The trial ran from 18 weeks until 25 weeks for barrows and from 19 till 26 weeks for gilts. Feed intake and daily gain of the pigs were measured after 2, 4, 6 and 7 weeks in trial. For the digestibility trial 4 pigs, with an average weight of 90 kg during the trial, were fitted with a PVTC-canula at the end of the ileum (Van Leeuwen, 2002). Non feed-dependent endogenous amino acid losses were estimated with the technique of the protein-free diet. Acid insoluble ash at 0.5% was used as a marker. To the fistulated pigs the lowest and the highest Lys-level diets, as well as the protein-free feed, were administered at 90 x (live weight)$^{0.75}$ g, according to a Latin square design, with 1 spare pig. Chyme was collected for 4 days; samples of 2 consecutive days were pooled. Samples were analysed for acid insoluble ash, amino acids and crude protein.
Animal performance variables were processed with the Multivariate GLM procedure (SPSS) with as fixed factor Lys-level and as covariable start weight. Estimated marginal means were compared with the F-test (adjustment for multiple comparisons: Sidak). Polynomial contrasts were calculated to evaluate linear or quadratic trends of the variables as a function of Lys-level. The ADG or FCR data were plotted against SID Lys-levels. Broken-line and quadratic models were used to fit the ADG and FCR data. The optimum for the broken-line was obtained by calculating the intersection of the two lines. The optimum of the quadratic curves was calculated as the value of x for which the first derivative equals zero.

Abstract no. 524
Session no. P4.43

Results and discussion

In barrows, ADG was significantly affected by Lys-level during the first two weeks of the trial. The lowest Lys-level resulted in a lower ADG (752 g/d) than the other treatments (resp. 952, 958, 909, 915 g/d), the highest Lys-level was intermediate (855 g/d). FCR during the first two weeks of the trial did also show a significant Lys-effect. The lowest Lys-level had a higher (3.33) and thus less favourable FCR than the other treatments (from 2.73 to 2.84). From 2 to 7 weeks in trial, animal performance variables were not significantly affected by dietary Lys-level. Significant linear or quadratic contrasts were found for the variables daily feed intake (DFI) 0-2 weeks, ADG 0-2 weeks, ADG 0-7 weeks and FCR 0-2 weeks in barrows. The absence of any Lys-effects in the periods after the first two weeks in barrows, confirms that the observed quadratic Lys-contrast for ADG 0-7 weeks was due to the first two weeks. Hence, for the barrows the Lys-requirement is preferably split into the requirement for the first two weeks of the experimental period and the requirement for the remaining weeks. For barrows, the ADG 0-2 weeks data could not be fitted by broken-line, quadratic or asymptotic models (Fig. 1). However, there was a significant improvement in ADG from 0.47 to 0.58% SID Lys, increasing Lys beyond this level did not further improve ADG. Hence, the requirement was met by 0.58% SID Lys. For FCR 0-2 weeks, a broken-line model was applied (Fig. 2), with the intersection at 0.59% SID Lys (point where plateau was reached), which is similar to the value for ADG. In the interval 2-7 weeks of the trial, there was no Lys-effect on ADG or FCR, so the requirement was fulfilled with 0.47% SID Lys.

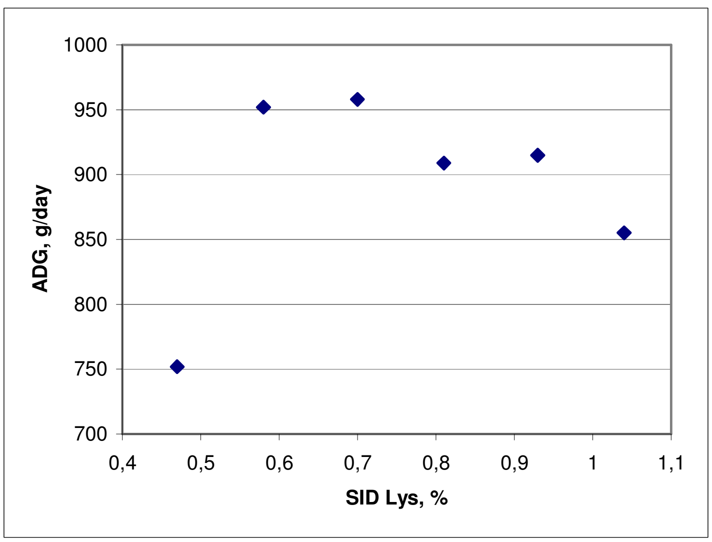

Fig. 1. ADG as a function of Lys-level: barrows 0-2 weeks in trial

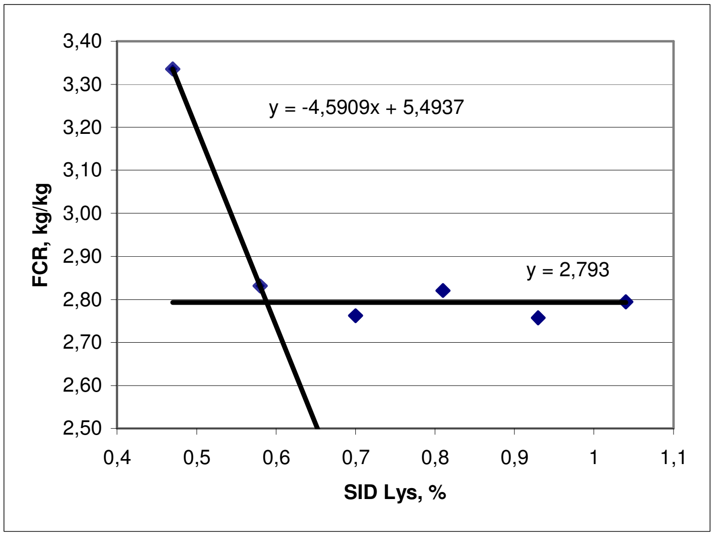

Fig. 2. FCR as a function of Lys-level: barrows 0-2 weeks in trial

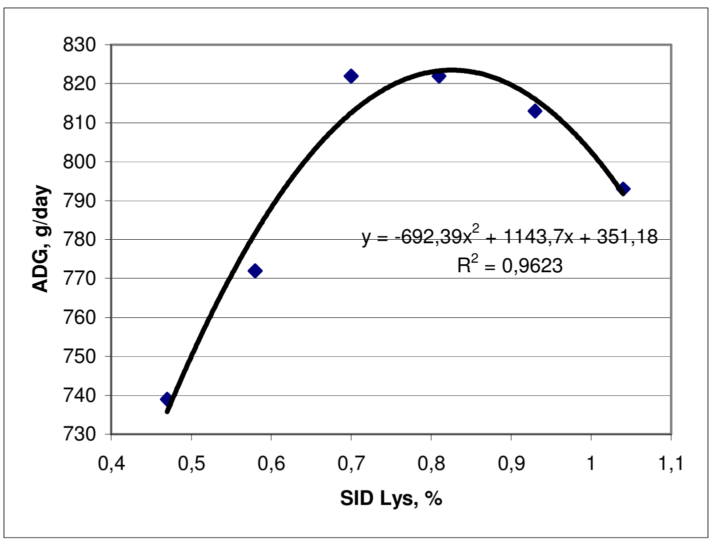

Fig. 3. ADG as a function of Lys-level: gilts 0-7 weeks in trial

In gilts, the animal performance variables were not significantly affected by Lys-level, with the exception of FCR 0-7 weeks. The lowest Lys-level treatment had a significant higher FCR (3.31) than the third (3.02), fourth (2.93), fifth (2.98) and sixth or highest Lys-level (2.95), the second Lys-level was intermediate (3.18). Significant linear or quadratic contrasts were found for DFI 0-2 weeks, ADG 0-2 weeks, ADG 4-6 weeks, ADG 0-7 weeks, FCR 0-2 weeks, FCR 2-4 weeks, FCR 4-6 weeks and FCR 0-7 weeks in gilts. The Lys-requirement in gilts could be estimated by quadratic models based on ADG 0-7 weeks and FCR 0-7 weeks (Figs. 3 and 4). The optima were given by the value of x for which the first derivative was zero. For ADG 0-7 weeks, 0.83% SID Lys was obtained and for FCR 0-7 weeks, 0.92% SID Lys was calculated.

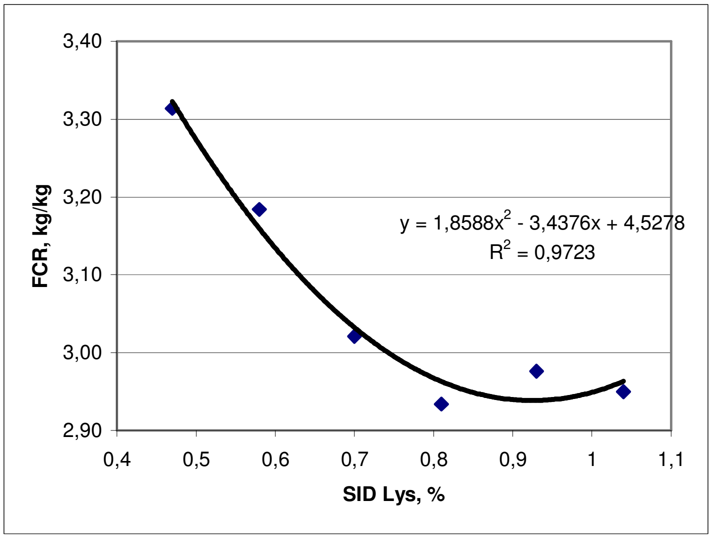

Fig. 4. FCR as a function of Lys-level: gilts 0-7 weeks in trial

Table 1. Lys-requirements for fattening pigs

Author	Range	Unit	Requirement, %	Energy content (kcal/kg)
Yen et al., 1986	50-90 kg	total Lys total Lys	0.72 (barrows) 0.84 (gilts)	3069 ME 3069 ME
CVB, 1996	70-110 kg	AID Lys	0.62	2200 NEv
Degussa, 2001	70-105 kg	SID Lys	0.71	3100 ME
De Schrijver & Vande Ginste, 1998	70-100 kg	AID Lys SID Lys	0.68 0.70	2250 NEv
AWT, 1998	70-105 kg	AID Lys	0.68	3059 ME
NRC, 1998[1]	75 kg (average 70-80 kg) 90 kg (average 70-110 kg) 95 kg (average 80-110 kg)	SID Lys SID Lys SID Lys	0.77 (barrow) 0.88 (gilt) 0.69 (barrow) 0.86 (gilt) 0.66 (barrow) 0.79 (gilt)	2200 NEv or 3365 ME
Cline et al., 2000	54-116 kg	total Lys	0.80 (gilt)	2290 NEv
Present experiment	70-82 kg (18-20 weeks) 70-82 kg (18-20 weeks) 82-110 kg (20-25 weeks) 82-110 kg (20-25 weeks) 70-110 kg (19-26 weeks) 70-110 kg (19-26 weeks)	SID Lys	0.58 (barrow) (ADG) 0.59 (barrow) (FCR) ≤ 0.47 (barrow) (ADG) ≤ 0.47 (barrow) (FCR) 0.83 (gilt) (ADG) 0.92 (gilt) (FCR)	2200 NEv or 3365 ME

[1]NRC: the requirement was calculated using the NRC model for AA-requirement, while using the parameter values obtained in the present trial. Feed: 3365 kcal ME/kg, 1.44 m²/pig, T°: 18°C, ME-intake: according to observed feed intake (for optimum performance) in the corresponding weight category.

Assumed lean gain between 20 and 120 kg: 402 g/d (barrow) and 414 g/d (gilt), based on an NRC-equation.

Conclusion

In conclusion, for barrows the SID Lys-requirement for the first 2 weeks in trial (70-80 kg) is met by 0.59% SID Lys (ADG & FCR), afterwards (80-110 kg) the requirement is satisfied by 0.47% SID Lys. In gilts the SID Lys-requirement, derived from the data and curves of the present trial, for the whole trial period (70-110 kg) amounts to 0.83% (ADG) and 0.92% (FCR). However, the ADG- and FCR-curves for gilts demonstrate that from 0.70% SID Lys on, little extra gain in animal performance is to be expected by increasing dietary Lys. Hence, the economic optimum is probably lower than the calculated requirements for gilts.

For barrows the requirements from the literature are higher than the requirement for the periods 70-80 kg and 80-110 kg in this study. For gilts, most of the requirements found in the literature are lower than the requirements from the present trial, with the exception of the NRC (1998) requirement. Gilts appear to have a higher essential amino acid requirement than barrows, which can be explained by their lower feed intake capacity and higher lean gain.

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