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Estimation of the standardized ileal digestible lysine requirement and the ideal ratio of threonine to lysine for late finishing gilts fed low crude protein diets supplemented with crystalline amino acids

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ABSTRACT

Two experiments were conducted to investigate the effects of various standard ileal digestible (SID) lysine (Lys) levels and SID threonine (Thr) to Lys ratios on the performance and carcass characteristics of finishing gilts receiving low crude protein (CP) diets supplemented with crystalline amino acids (CAA). In Exp. 1, 108 gilts (87.8 ± 5.9 kg) were randomly allotted to one of six diets which consisted of a high CP (135 g/kg) diet with 6.1 g/kg SID Lys or five low CP (100 g/kg) diets providing SID Lys levels of 4.9, 5.5, 6.1, 6.7 and 7.3 g/kg, respectively. Gilts were housed in three pigs per pen with six pens per treatment. At the end of the 28 days experiment, 36 gilts (one pig per pen) with average body weight (BW) of 116 kg were killed to evaluate carcass traits. The SID Lys levels required to maximize average daily gain (ADG) and optimize feed conversion ratio (FCR) as well as to minimize serum urea nitrogen (SUN) levels were 5.7, 5.8 and 6.1 g/kg using a linear-break point model and 6.5, 6.5 and 6.6 g/kg using a quadratic model. The fat-free lean gain tended to increase linearly with the increase in dietary SID Lys levels from 4.9 to 7.3 g/kg when gilts receiving a low CP diet (linear effect, P=0.06). In Exp. 2, 90 gilts (90.6 ± 5.7 kg) were utilized in another dose–response study. Based on the Lys requirement estimated in Exp. 1, dietary treatments were formulated to contain 5.1 g/kg SID Lys to ensure the dietary Lys level was marginally deficient for late finishing gilts. Graded levels of crystalline Thr (0, 0.3, 0.6, 0.9 or 1.2 g/kg) were added to the basal diet providing SID Thr to Lys ratios of 0.54, 0.60, 0.66, 0.72 or 0.78, respectively. Each diet was fed to six pens with three gilts per pen. At the end of Exp. 2, 30 gilts (one pig per pen) were slaughtered to evaluate carcass traits (average BW = 118 kg). The optimum SID Thr to Lys ratios to maximize ADG and FCR as well as to minimize SUN levels were 0.61, 0.63 and 0.64 using a linear-break point model and 0.70, 0.75 and 0.74 using a quadratic model. With the exception of L* light (linear effect, P<0.05), no effect on carcass characteristics was observed with increasing dietary SID Thr to Lys ratio.

Abbreviations: AA, amino acid; ADFI, average daily feed intake; ADG, average daily gain; BW, body weight; CAA, crystalline amino acids; CP, crude protein; FCR, feed conversion ratio; Lys, lysine; SID, standard ileal digestible; SUN, serum urea nitrogen; Thr, threonine.

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1. Introduction

Considering the entire growth phase, late finishing pigs have the highest feed intake and poorest feed conversion. Suggested dietary manipulations for feed formulation include the use of phase feeding and low-protein diets supplemented with crystalline amino acids (CAA) to achieve economic and environmental benefits (Prandini et al., 2013).

Lysine (Lys) and threonine (Thr) are often the first- or second-limiting amino acid (AA) for finishing pigs fed a maize-soybean meal based diet (Saldana et al., 1994; Shelton et al., 2011). The requirement for Lys and Thr can be significantly influenced by body weight (BW), which may be due to the increased proportion of protein deposition and maintenance for amino acid requirements for pigs moving towards the finishing period (Friesen et al., 1994; Hahn and Baker, 1995). A large deficiency of Lys and Thr may appear by reducing dietary soybean meal concentration, which may lead to poor performance in finishing pigs. This can be overcome by supplementing the diet with CAA but these tend to be expensive and it is important to ensure appropriate levels of CAA are used in the diet (Zhang et al., 2013).

In late finishing period, gilts usually need higher amino acid levels than barrows because of the greater lean growth rate and reduced feed intake of gilts (Friesen et al., 1994; King et al., 2000). It is important to recognize that Lys and Thr requirements should be evaluated separately based on gender of pigs in order to feed the animal closer to its requirement. The NRC (2012) estimates the Lys requirement of 100–135 kg gilts to be 6.4 g/kg standard ileal digestible (SID) Lys while the National Swine Nutrition Guide (2010) estimates the SID Lys requirement of 100–120 kg gilts to be 6.9 g/kg for high lean gain lines and 5.9 g/kg for medium lean gain lines. The similar estimates of ratio of SID Thr to Lys ranged from 0.66 to 0.68 for late finishing gilts in NRC (2012) and National Swine Nutrition Guide (2010). However, the recommended estimates were based on predictable model and there were limited empirical studies in finishing pigs, especially on the basis of SID AA (NRC, 2012). The aims of this study were to determine the SID Lys requirement and optimum dietary Thr to Lys ratio for late finishing gilts fed low crude protein (CP) diets supplemented with CAA.

2. Materials and methods

All experimental procedures and animal care were approved by the China Agricultural University Animal Care and Use Committee (Beijing, China).

2.1. Animals, housing and dietary treatments

Two trials were conducted to determine the SID Lys requirement and the optimum dietary SID Thr to Lys ratio for late finishing gilts (Duroc × Yorkshire × Landrace) fed low CP diets supplemented with CAA. Both experiments were conducted at the Pig Research Facility at the Swine Nutrition Research Centre of the National Feed Engineering Technology Research Centre (Chengde, Hebei Province, China).

Gilts were placed in partially steel-slatted concrete floored pens (2.4 m × 1.8 m) that provided 1.3 m^2 per pig in a finishing facility. Each pen was equipped with a stainless steel self-feeder and a nipple drinker. Pens of pigs (three gilts per pen) were allotted to one of six (Exp. 1) or five (Exp. 2) dietary treatments in a randomized complete block design with six replicates per treatment and had free access to water and feed. At the beginning and end of the experiments, all gilts were weighed after an overnight fast (feeders were cleaned out) and feed disappearance was determined to determine average daily gain (ADG), average daily feed intake (ADFI) and feed conversion ratio (FCR).

The experimental diets were formulated based on maize, wheat bran and soybean meal (Exp. 1) or maize and wheat bran (Exp. 2). With the exception of Thr (Exp. 2), the ratios of the remaining indispensable SID AAs to SID Lys in the experimental diets were formulated to meet 110% of the recommendations of NRC (2012). The SID AA content for all experimental diets were estimated by multiplying the analyzed total AA levels in maize, soybean meal and wheat bran by the SID coefficients of the corresponding AA in those feedstuffs obtained from NRC (2012) and summing the values. The efficiency of the utilization of CAA was assumed to be 100% (Tuitoek et al., 1997).

2.1.1. Experiment 1

This study was conducted to determine the optimum SID Lys requirement for finishing gilts (88–116 kg) fed low protein diets supplemented with CAA. One hundred and eight finishing gilts were allotted to one of six dietary treatments including a high CP (135 g/kg) diet with 6.1 g/kg SID Lys or five low CP (100 g/kg) diets (supplemented with Lys, Thr, methionine, tryptophan, isoleucine and valine) providing SID Lys levels of 4.9, 5.5, 6.1, 6.7, 7.3 g/kg, respectively (Tables 1 and 2). Alanine and corn starch were added to produce isonitrogenous for low CP diets. Gilts were housed three pigs per pen with six pens per treatment for a 28 days trial.

2.1.2. Experiment 2

Experiment 2 was another dose–response study lasting for 28 days conducted to determine the optimum dietary SID Thr to Lys ratio for 90–118 kg gilts fed low CP diets supplemented with CAA. Ninety finishing gilts were allotted to one of five dietary treatments. The experimental diets were formulated to provide SID Lys of 5.1 g/kg ensuring that Lys was marginally deficient for pigs based on the results in Exp. 1. Crystalline L-Thr was added to the basal diet to formulate dietary SID Thr to