



Lysine requirement relative to total dietary protein for optimum performance and carcass protein deposition of Iberian piglets

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ABSTRACT

This work aims at establishing dietary Lys requirements [g Lys/kg crude protein (CP, N × 6.25)] of post-weaned Iberian piglets based on responses on growth performance, carcass nutrient deposition and plasma metabolites. Sixty piglets (10.7 ± 0.1 kg initial BW) were randomly assigned into six isoenergetic diets based on corn, barley and soybean meal. Diets contained increasing Lys concentrations at a constant dietary CP content (165 ± 0.7 g/kg DM). L-Lys HCl was added at the expense of corn starch providing Lys:CP ratios (g/kg) of 43, 47, 52, 57, 64 and 72 g/kg. Other amino acids and nutrients remained constant. Six additional piglets were slaughtered at the start of the experiment to estimate initial carcass composition. Piglets were individually housed in 2 m² pens in an environmentally controlled room until slaughter (25.3 ± 0.4 kg BW) to analyze carcass composition. Average daily gain, G:F and Gain:ME intake (g/MJ) increased linearly (P < 0.001) on increasing Lys concentration. Using average daily gain as a response, the linear broken-line regression and the first derivative of the quadratic function gave the same estimation for Lys requirement (71.0 g Lys/kg dietary CP, respectively). Lysine content of dietary protein has no effect upon the apparent digestibility of DM, OM and nitrogen. Carcass protein deposition (PD) increased linearly (P < 0.001) and quadratically (P < 0.05) on increasing dietary Lys, reaching maximum values (39.3–40.2 g protein/d) with diets providing 57, 64 and 72 g Lys/kg CP. Carcass PD:CP intake, and carcass PD:digestible protein intake increased linearly (P < 0.001) and quadratically (P < 0.05) on increasing dietary Lys concentration. The linear broken-line regression using carcass PD (g/d) as response criterion estimated Lys requirement as 58.6 g Lys/kg dietary CP with a plateau PD value of 39.9 g/d. The first derivative of the quadratic function relating carcass PD and dietary Lys content gave a value of 63.7 g Lys/kg CP. Plasma urea concentration tended to decrease on increasing Lys concentration (P = 0.06 and P = 0.10, for linear and quadratic effects). For plasmatic urea, both linear and quadratic approach gave a similar estimate for Lys requirements, 61.2 g Lys/kg dietary CP. It is concluded that the preferred estimate based on carcass PD – the more reliable measure of metabolic Lys utilization – is 63.7 g Lys/kg CP, somewhat below the established for conventional piglets.

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Abbreviations: AA, amino acid; ATTD, apparent total tract digestibility; ADG, average daily gain; BW, body weight; CP, crude protein; DM, dry matter; EBW, empty body weight; Lys, lysine; ME, metabolizable energy; N, nitrogen; PD, protein deposition.

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1. Introduction

A key factor affecting the efficiency of use of dietary protein for growth and lean tissue deposition is the AA composition of dietary protein, specifically, the essential AA composition. The ideal dietary AA profile – or ideal protein – is the one that contains the optimum balance of AA required for maintenance and productive functions. This balance has been established for pigs, with variations according to the physiological state of the animal (BSAS, 2003; NRC, 2012). Pig genotype might influence such balance, although there is little information available concerning this issue, particularly for breeds of low capacity for lean tissue deposition. Iberian are obese, slow-growing pigs. In previous work we have shown that their requirements for total protein differ markedly from those of pigs of conventional genotypes (Nieto et al., 2012). Dietary protein in these studies was formulated following the optimum AA pattern (g AA/kg crude protein) established for conventional growing pigs (NRC, 1998; BSAS, 2003). The first step to investigate the ideal protein profile for Iberian pigs is to determine if the optimum (Lys) proportion of dietary protein differs from those established for conventional pigs. Previous studies suggested less sensibility to Lys deficiency in pure-Iberian than in Landrace gilts (Rivera-Ferre et al., 2006) fed diets of adequate protein content to each pig type. Although traditionally these pigs were raised outdoors, current systems favor intensive management during growing and early stages of finishing periods. We aim at establishing dietary Lys requirements (g Lys/kg CP) of post-weaned Iberian piglets based on animal responses on growth performance, carcass nutrient deposition and plasma metabolites. This information will be very valuable for maximizing lean growth and achieving optimum profitability, particularly during the early growth stage, the most efficient phase in conversion of nutrients to animal tissues (Kendall et al., 2008).

2. Materials and methods

The experimental protocol was reviewed and approved by the Bioethical Committee of the Spanish National Research Council (CSIC), Spain, and pigs were cared for following the Spanish Ministry of Agriculture guidelines (Boletín Oficial del Estado, 2005).

2.1. Animals, experimental design, diets and feeding

A total of 66 purebred castrated male Iberian piglets (Silvela strain) were used in this trial. They were weaned at 28 d of age and allowed *ad libitum* access to a commercial pre-starter diet (195 g CP and 14 g Lys per kg; as-fed basis). At 48 ± 2 d of age, 60 of them (10.7 ± 0.1 kg BW) were randomly assigned to six experimental treatments. Ten piglets were allocated into each experimental diet. At the start of the trial six additional piglets were slaughtered to estimate initial carcass composition. The piglets were individually housed in 2 m² pens in an environmentally controlled room (28 ± 2 °C decreasing steadily to 20 ± 2 °C when they weighed 20 kg BW) until slaughter. Body weight was recorded weekly. The experiment lasted 33 d when the animals reached approximately 25 kg BW.

Six isoenergetic diets (Table 1), based on corn, barley and soybean meal, were formulated to provide increasing Lys concentrations (7–12 g Lys/kg DM) at a constant CP content (165 ± 0.7 g/kg DM). Other nutrients, including amino acids (AA), remained constant and in sufficient amounts (NRC, 1998; BSAS, 2003). Lysine (L-Lys HCl) was added at the expense of corn starch to provide Lys: CP ($N \times 6.25$) ratios (g/kg) of 45, 50, 55, 60, 65 and 70. Actual analyzed Lys:CP ratios were 43, 47, 52, 57, 64 and 72 g/kg. Diets were offered in 2 daily equal meals (0900 and 1500 h) with a slight restriction to minimize feed refusals. The actual daily feed allowance was calculated based on piglets' BW, measured individually each week, according to previous determination of voluntary feed intake of Iberian piglets of the same BW range, as described by Conde-Aguilera et al. (2011a). When feed refusals occurred, they were daily collected and recorded. Water was freely available.

2.2. Measurements

The inert marker, Cr₂O₃, was used to estimate total tract apparent digestibility (ATTD) of nutrients, which was determined at approximately 17 kg BW in six selected piglets from each dietary treatment. The selection was based on the availability of metabolic cages. Piglets of BW similar to the average of their own groups were chosen. Digestibility measurements were performed as described by Conde-Aguilera et al. (2011a). Briefly, three days before starting excreta collection, piglets were individually placed in metabolic cages and fed diets including chromic oxide (5 g/kg) at least 5 d before starting digestibility measurements. Spot feces samples (uncontaminated of spoiled feed) and urine (into 50 mL 4 M H₂SO₄) were collected daily during 5 d and stored at -20 °C. At the end of the collection period, after thawing overnight, feces and urine samples from the 5 d collection were pooled to form 1 sample of each material for each pig and stored at -20 °C until analysis. The apparent total tract digestibility of DM (DM ATTD; g DM apparently digested/g DM ingested) was calculated as: $DM\ ATTD = 1 - (Cr_2O_3f/Cr_2O_3e)$, where Cr₂O₃f and Cr₂O₃e are Cr₂O₃ concentration in feed and feces, respectively. The apparent total tract digestibility of dietary nutrients (Dn ATTD; g nutrient apparently digested/g nutrient ingested) or energy (DE ATTD; kJ energy apparently digested/kJ energy ingested) was calculated from the equation: $Dn\ ATTD\ (or\ DE\ ATTD) = 1 - [(Qe \times Cr_2O_3f)/(Qf \times Cr_2O_3e)]$, where Qe and Qf are nutrient (or energy) concentration in fecal excretion and feed, respectively.

At slaughter (25.3 ± 0.4 kg BW) seven piglets of BW close to the average of the group were chosen from each dietary treatment to be slaughtered by electrically stunning and exsanguination. Immediately after slaughter, the gastrointestinal

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