Meta-Analysis of Lysine Requirement and Its Influencing Factors in 10–25 kg Piglets (Postprint)

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Abstract

This study aimed to apply Meta-analysis to investigate the lysine (Lys) requirement and its influencing factors in 10–25 kg piglets. Research on Lys requirements in piglets published between 1990 and 2016 was retrieved, and a total of 17 studies were included based on literature screening criteria. The standardized ileal digestible lysine (SID Lys) requirement was estimated using quadratic (QC), linear plateau (LP), and curvilinear plateau (CLP) models. The results indicated that the LP model yielded lower SID Lys requirement estimates, whereas the QC and CLP models produced higher and essentially consistent estimates. Variation in dietary SID Lys content did not affect average daily feed intake (ADFI) in piglets (PQC=0.8280, Plinear=0.5844); using average daily gain (ADG) and feed-to-gain ratio (F/G) as response variables and SID Lys content as the independent variable, the QC model estimated dietary SID Lys requirements for 10–25 kg piglets to be 1.280% ($P<0.0001$) and 1.260% ($P<0.0001$), respectively. Diet type and genetic background were among the factors influencing SID Lys requirement. The SID Lys requirements for corn-soybean meal diets and non-corn-soybean meal diets were 1.307% ($P=0.0050$) and 1.138% ($P=0.0001$), respectively; those for Chinese indigenous pig breeds and lean-type pig breeds were 1.060% ($P=0.0012$) and 1.334% ($P=0.0043$), respectively. In summary, to achieve optimal growth performance in 10–25 kg piglets, the dietary SID Lys requirement ranges from 1.230% to 1.280%, with consideration of diet type and pig genetic background.

Full Text

Lysine Requirement and Its Influence Factors of 10 to 25 kg Piglets: A Meta-Analysis

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Abstract: This study aimed to investigate the lysine (Lys) requirement and its influencing factors in 10–25 kg piglets using meta-analysis. Publications examining Lys requirements in piglets from 1990 to 2016 were retrieved, and 17 studies were included based on selection criteria. The quadratic curve (QC) model, linear-plateau (LP) model, and curvilinear-plateau (CLP) model were employed to estimate the standardized ileal digestible lysine (SID Lys) requirement. The results indicated that the LP model yielded lower SID Lys requirement estimates, while the QC and CLP models produced higher and relatively consistent estimates. Dietary SID Lys content did not affect average daily feed intake (ADFI) (P_{QC} = 0.8280, P_{linear} = 0.5844). When using average daily gain (ADG) and feed-to-gain ratio (F/G) as dependent variables and dietary SID Lys content as the independent variable, the QC model estimated SID Lys requirements of 1.280% ($P < 0.0001$) and 1.260% ($P < 0.0001$), respectively, for 10–25 kg piglets. Dietary type and genetic background significantly influenced SID Lys requirements. Specifically, SID Lys requirements were 1.307% ($P = 0.0050$) for corn-soybean meal diets and 1.138% ($P = 0.0001$) for non-corn-soybean meal diets. For Chinese local pig breeds and lean-type pig breeds, SID Lys requirements were 1.060% ($P = 0.0012$) and 1.334% ($P = 0.0043$), respectively. In conclusion, the dietary SID Lys requirement for optimal growth performance in 10–25 kg piglets ranges from 1.230% to 1.280%, with dietary type and genetic background warranting consideration.

Keywords: 10–25 kg piglets; Lys requirement; influencing factors; meta-analysis; statistical model

Lysine (Lys) is the first limiting amino acid in conventional swine diets. Numerous studies have investigated Lys requirements in pigs, yet results vary considerably, likely due to differences in body weight, sex, genetic potential for protein deposition, and experimental conditions [1]. Additionally, the statistical methods used to assess optimal response, dietary amino acid balance, and diet type can influence predicted Lys requirements [2].

Meta-analysis is a quantitative review method that increases statistical power by synthesizing multiple independent studies on the same scientific question [3]. It has been widely applied in animal nutrition research globally [4-5]. Previous meta-analyses have examined branched-chain amino acid requirements (tryptophan, valine, and isoleucine) [6-8], milk yield in dairy cows [9], Lys requirements in growing-finishing pigs [10], and the effects of biotin and niacin on dairy performance [11-12], as well as trace elements on broiler performance [13]. However, no meta-analysis has specifically addressed Lys requirements in piglets.

Common methods for predicting nutrient requirements include the quadratic curve (QC) model [3,10-11,13-14], linear-plateau (LP) model, and curvilinear-plateau (CLP) model [6]. Even with identical databases, different models can yield substantially different nutrient requirement estimates [6]. Therefore, this study employed QC, LP, and CLP models to determine the SID Lys requirement of 10–25 kg weaned piglets through meta-analysis and to identify factors influencing Lys requirements, providing a scientific basis for swine production and feed formulation.

1.1 Literature Search

English databases including Web of Science, PubMed, Elsevier, ScienceDirect, Wiley Online Library, Springer, Taylor & Francis Online, and OVID Agricultural Electronic Information Platform were searched using the keywords "pig" or "swine" , "lysine" , "requirement" or "supplementation" , and "growth" or "performance" . Chinese databases including CNKI, Wanfang, VIP, and the Chinese Science Citation Database (CSCD) were searched using the terms "pig" , "lysine" , "requirement" or "addition level" , and "growth" or "growth performance" . The search period spanned 1990–2016, including relevant Chinese literature and master' s and doctoral dissertations (excluding conference papers and unpublished studies).

1.2 Literature Selection Criteria

Retrieved literature was screened according to the following criteria: (1) studies investigating Lys requirements in pigs; (2) a minimum of three Lys gradient levels; (3) complete dietary formulation provided; and (4) growth performance data including average daily feed intake (ADFI), average daily gain (ADG), and feed-to-gain ratio (F/G) measured.

1.3 Data Collection and Calculation

When analyzing animal performance across different nutrient levels, evaluation of dietary nutritional value may represent an important source of uncontrolled variation. Therefore, in this meta-analysis, dietary composition and nutrient content were standardized across studies, and net energy (NE) and standardized ileal digestibility (SID) of amino acids were recalculated for each experimental diet based on provided formulations.

Each publication reported initial body weight, though final weight was sometimes missing and calculated from ADG and trial duration. Missing ADG values were computed from available information on dietary formulation and ADFI. When F/G was not reported, it was calculated from ADG and ADFI. Units for variables were standardized as follows: dietary standardized ileal digestible amino acids (SID AA) as percentage of diet (%), energy in megajoules (MJ), body weight in kilograms (kg), feed intake in grams per day (g/d), Lys intake in grams per day (g/d), and daily gain in grams per day (g/d).

1.4 Statistical Analysis

For multi-level trial analysis in meta-analysis, SAS Mixed models were used. Heterogeneity among studies (diet, breed, special additive use, animal condition, statistical methods, etc.) was assumed, and study effects were corrected to eliminate inter-study differences, thereby integrating all studies into a unified analysis of Lys level effects [11].

Relationships between dependent variables (ADFI, ADG, and F/G) and independent variables [dietary standardized ileal digestible lysine (SID Lys)] were analyzed using SAS PROC MIXED with the following general model:

$$Y_{ij} = B_0 + B_{1X_{ij}} + B^2_{2X_{ij}} + S_i + b_{1i}X_{ij} + b_{2i}X^2_{ij} + e_{ij}$$

where i represents study number ($i = 1, 2, 3, \dots, n_i$); j represents observation number within each study ($j = 1, 2, 3, \dots, n_i$); B_0 is the overall intercept (fixed effect); B_1 and B_2 are the linear and quadratic coefficients across studies (fixed effects); X_{ij} is the independent variable for observation j in study i; S_i is the random intercept for study i; b_{1i} and b_{2i} are the linear and quadratic coefficients for study i (random effects); and e_{ij} is the residual error, assumed to be normally distributed $N(0, \sigma^2)$.

The SAS mixed-effects code was implemented as follows:

```
data ex;
  do a = 1 to n;
    input n @@;
    do i = 1 to n;
      input X Z Y @@;
      Output;
    end;
  end;
cards;

PROC MIXED data = ex;
  CLASS a;
  MODEL Y = X Z / Solution OUTP = Predictionset OUTPM = PredY;
  RANDOM intercept X / G SUBJECT = a;
```

Adjusted SID Lys content and growth performance indicators (ADFI, ADG, and F/G) were used as coordinates to fit QC, LP, and CLP models. The general model forms were:

QC model: $Y_{ij} = a + bX_{ij} + cX^2_{ij}$
LP model: $Y_{ij} = L_i[1 + U(R - X_{ij})]$ for $X_{ij} < R$; $Y_{ij} = L_i$ for $X_{ij} \geq R$
CLP model: $Y_{ij} = L_i[1 + U(R - X_{ij})^2]$ for $X_{ij} < R$; $Y_{ij} = L_i$ for $X_{ij} \geq R$

where Y_{ij} is the dependent variable (e.g., ADG, ADFI, F/G); X_{ij} is the independent variable for observation j in study i; i represents study number ($i = 1, 2, 3, \ldots, 33$); j represents observation number within each study ($j = 1, 2, 3, \ldots, n_i$); U, a, b, c are constants; L_i is the maximum predicted value (plateau) of the dependent variable; and R is the minimum X value at which Y_{ij} reaches its maximum (L_i).

Based on selection criteria, 17 publications [2,15-30] were included in this study. The screening process and literature exclusion details are shown in [Figure 1: see original paper]. Experimental designs from all included studies were analyzed, and specific treatment groups were selected to establish the comprehensive database ().

2.1 Database

[Figure 1: see original paper] Meta-analysis literature selection process

2.2 Data Characteristics

This meta-analysis included 17 publications comprising 99 treatment groups and 4,735 piglets. Antibiotics were added to diets in 16 studies, while one study used antibiotic-free diets [21]. Research originated primarily from the United States (23.5%), China (29.4%), Brazil (23.5%), Canada (5.9%), Poland (5.9%), Mexico (5.9%), and Spain (5.9%). All dietary formulations met the NE recommendations of NRC (2012). Additionally, treatment groups from studies examining energy-to-Lys ratios that met energy requirements were included in subsequent analyses.

Dietary formulations were recalculated according to NRC (2012) feed ingredient nutrient contents, and regression analysis examined the relationship between calculated and reported SID Lys values ([Figure 2: see original paper]). Results showed high agreement between calculated and reported values ($P < 0.0001$, $R^2 = 0.9162$). The relationship between dietary Lys content and ADG reported in all included studies is shown in [Figure 3: see original paper].

[Figure 2: see original paper] Regression analysis of calculated values and values reported in publications for SID Lys

[Figure 3: see original paper] Variation trend of ADG with dietary Lys content

2.3 SID Lys Requirement of 10–25 kg Piglets

Using SID Lys as the independent variable and growth performance indicators (ADFI, ADG, and F/G) of 10–25 kg piglets as dependent variables, the minimum dietary SID Lys content required for optimal growth performance was analyzed. Results showed no significant quadratic or linear relationship between ADFI and dietary Lys content (P_{QC} = 0.8280, P_{linear} = 0.5844). However, both ADG and F/G exhibited significant quadratic relationships with dietary Lys content ($P < 0.0001$).

2.3.1 QC Model Estimation of SID Lys Requirement

Using SID Lys as the independent variable and adjusted ADG and F/G as dependent variables, the QC model estimated SID Lys requirements for 10–25 kg piglets (). The SID Lys requirements were 1.280% ($Y\_\{ADG\} = -289.4X^2 + 741.3X + 110.1$, $n = 99$, $R^2 = 0.745$, $P < 0.0001$) and 1.260% ($Y\_F/G = 1.351X^2 - 3.406X + 3.788$, $R^2 = 0.895$, $P < 0.0001$), corresponding to ADG and F/G of 584.8 g/d and 1.64, respectively ([Figure 4: see original paper]).

The QC model estimates were slightly higher than NRC (2012) recommendations (1.230% for 11–25 kg), which predicted ADG and F/G of 585.0 g/d and 1.63, respectively.

Parameter tables of quadratic curve model, linear-plateau model, and curvilinear-plateau model

[Figure 4: see original paper] Variation trend of adjusted ADG and F/G with dietary SID Lys content (QC model) [2,15-30]

2.3.2 LP and CLP Model Estimation of SID Lys Requirement

LP and CLP models were used to estimate SID Lys requirements ([Figure 5: see original paper],). All three models predicted similar optimal growth performance, but optimal SID Lys requirements differed. The LP model estimated requirements of 1.102% (based on ADG) and 1.070% (based on F/G), which were lower than both NRC (2012) recommendations and estimates from the CLP model [1.274% (ADG) and 1.230% (F/G)] and QC model [1.280% (ADG) and 1.260% (F/G)].

[Figure 5: see original paper] Variation trend of adjusted ADG and F/G with dietary SID Lys content (LP and CLP models)

2.4 Factors Influencing SID Lys Requirement of 10–25 kg Piglets

2.4.1 Diet Type

Based on energy feed ingredient composition, diets were classified as corn-soybean meal or non-corn-soybean meal types. SID Lys requirements were 1.307% ($P = 0.005$) and 1.138% ($P = 0.0001$), respectively, with corresponding ADG values of 592.5 g/d and 548.1 g/d. This indicates that piglets fed non-corn-soybean meal diets exhibited lower growth performance and had correspondingly lower SID Lys requirements ([Figure 6: see original paper]).

[Figure 6: see original paper] Effects of non-corn-soybean meal diet (A) [15,19,21,24,29] and corn-soybean meal diet (B) [2,16-18,20,22-23,25-28,30] on

SID Lys requirement

Y_{non}-corn-soybean = $-537.5X^2 + 1223.0X - 147.6$ ($R^2 = 0.968$, n = 21, P = 0.0001)
Y_{corn}-soybean = $-257.2X^2 + 672.1X + 153.4$ ($R^2 = 0.612$, n = 78, P = 0.0050)

2.4.2 Genetic Background

The optimal SID Lys requirement for Chinese local pig breeds was 1.060% (P = 0.0012) with corresponding ADG of 425.4 g/d, while lean-type pig breeds required 1.334% (P = 0.0043) with ADG of 632.2 g/d ([Figure 7: see original paper]). This demonstrates that Chinese local breeds have lower growth performance and consequently lower dietary SID Lys requirements.

[Figure 7: see original paper] Dietary SID Lys requirement of Chinese local pig breed (A) [21,26-27,29-30] and lean-type pig breed (B) [2,15-20,22-25,28]

Y_{local} = $-553.2X^2 + 1173.0X - 196.4$ ($R^2 = 0.793$, n = 24, P = 0.0012)
Y_{lean}-type = $-245.6X^2 + 655.3X + 195.1$ ($R^2 = 0.659$, n = 75, P = 0.0043)

3.1 Statistical Models

This study utilized three different analytical models (QC, LP, and CLP) to analyze SID Lys requirements for 10–25 kg piglets using SAS 9.4 software [14,31-32]. Using the same database, QC and CLP models produced very similar estimates: 1.280% (ADG) and 1.260% (F/G) for QC, versus 1.274% (ADG) and 1.230% (F/G) for CLP. In contrast, the LP model yielded lower estimates of 1.102% (ADG) and 1.070% (F/G).

Model selection significantly influences nutrient requirement estimates [3]. The LP model was once considered appropriate for estimating animal nutrient requirements [33-34] but typically underestimates amino acid needs [35]. Baker [33] recommended the CLP model to describe curvilinear responses and estimate nutrient requirements. Simongiovanni et al. [6] compared LP and CLP models in a 2012 meta-analysis of tryptophan requirements, concluding that CLP was more suitable for amino acid requirement estimation. St-Pierre [10] detailed the methodology for applying QC models to estimate animal nutrient requirements. The CLP and QC models are expressed as: Y_{ij} = L_i[1 + U(R - X_{ij})^2] for X_{ij} < R; Y_{ij} = L_i for X_{ij} ≥ R, and Y_{ij} = a + bX_{ij} + cX_{ij}^{2}, respectively. This indicates that the CLP model' s growth curve before the inflection point (X_{ij} = R) matches the QC model. To ensure continuity and smoothness in the CLP model, the plateau line (Y = L_{ij}) must be tangent to the quadratic curve [31]. Consequently, the CLP inflection point approximates the QC vertex, consistent with statistical principles.

Although QC and CLP models yield similar requirement estimates, their biological interpretations differ. In the CLP model, the optimal nutrient requirement represents the inflection point between the quadratic and plateau phases.

Beyond this point, increasing dietary Lys content does not affect piglet performance. In contrast, the QC model vertex represents the maximum nutrient requirement; exceeding this level inhibits performance. Thus, the CLP inflection point indicates the minimum nutrient level for optimal performance and cost efficiency, while the QC vertex represents the maximum level before performance declines.

Lysine is the first limiting amino acid in grain-based swine diets, with up to 80% utilized for protein synthesis in young animals [36]. NRC (2012) recommends Lys requirements for different piglet stages: 1.50% for 5-7 kg, 1.35% for 8-11 kg, and 1.23% for 12-25 kg. However, in Chinese swine production, piglets are typically weaned at 21-23 days (~7 kg), fed starter diets for 2 weeks to reach ~10 kg, then fed nursery diets until 9-10 weeks of age (~25-30 kg). Therefore, this meta-analysis of 10-25 kg piglet SID Lys requirements provides valuable guidance for Chinese swine production.

3.2 Factors Influencing SID Lys Requirement of 10-25 kg Piglets

3.2.1 Dietary Factors

Wheat and barley are important corn alternatives but contain higher levels of crude and soluble fiber [37]. While corn contains 1.2-1.6% crude fiber, 9.4% neutral detergent fiber (NDF), and 3.5% acid detergent fiber (ADF), wheat and barley contain 2.0-2.2% crude fiber, with hulled barley reaching 4.8%. Their NDF content ranges from 10-18% and ADF from 3.9%. Although no direct studies link dietary fiber to Lys requirements, fiber serves as an important energy source for gut microbiota, potentially improving microbial populations and fermentation parameters [38-40], reducing diarrhea, promoting digestive organ development, and enhancing digestive enzyme activity [41].

This study compared corn-soybean meal diets with mixed-grain diets based on wheat and barley (non-corn-soybean meal). Results showed SID Lys requirements of 1.307% ($P = 0.0050$) and 1.138% ($P = 0.0001$), respectively, with corresponding ADG values of 592.5 g/d and 548.1 g/d. This suggests that 10-25 kg piglets fed corn-soybean meal diets require 1.307% SID Lys—higher than NRC (2012) recommendations—to achieve greater ADG. When wheat and barley replace corn, SID Lys requirements and ADG are correspondingly lower.

3.2.2 Genetic Background

This meta-analysis included all Lys requirement studies meeting selection criteria, encompassing both Chinese local and lean-type pig breeds. Comparative analysis revealed that Chinese local breeds exhibited lower growth performance and SID Lys requirements (1.060%, $P = 0.0012$; ADG = 425.4 g/d) compared to lean-type breeds (1.334%, $P = 0.0043$; ADG = 632.2 g/d). Lean-type breeds showed ADG 47.2 g/d higher than NRC (2012) estimates. Continuous improvements in breed and management have enhanced feed efficiency [6]. Nemechek et al. [42] noted that NRC (1998) recommendations were inadequate (1.01% for 10-20 kg), and NRC (2012) subsequently increased Lys requirements. These meta-analysis results suggest that NRC (2012) recommendations may still be slightly below the level needed for optimal performance in lean-type pig breeds.

Using QC and CLP models, the SID Lys requirement for optimal growth performance in 10-25 kg piglets is estimated at 1.230-1.280%. NRC (2012) provides stage-specific recommendations of 1.50%, 1.35%, and 1.23% for 5-7, 7-11, and 11-25 kg, respectively. While these align generally with our meta-analysis results, the SID Lys requirement for 10-25 kg piglets may exceed NRC (2012) recommendations under practical production conditions with less precise stage division. Dietary amino acid balance, diet type, and genetic background should be considered. Specifically, corn-soybean meal and non-corn-soybean meal diets require 1.307% and 1.138% SID Lys, respectively, while Chinese local and lean-type pig breeds require 1.060% and 1.334%, respectively. These factors should be accounted for in feed formulation and swine production to meet requirements appropriately.

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Supplementary Table 1 Database of meta-analysis

Literature (published year)	Treatment Group	Genetic background	Antibiotics	Initial weight/kg	Final weight/kg	SID Lys reported in publications/%	Calculated SID AA/%	ADG/(g/d)	ADFI/(g/d)	F/G
Nam et al. [15] (1994)	T3 G1	(Duroc × Hampshire) × (Landrace × Large White)	Yes	10.5	25.0	1.15	1.15	585	950	1.62

Literature (published year)	Treatment Group	Genetic background	Antibiotics	Initial weight/kg	Final weight/kg	SID Lys reported in publications/%	Calculated SID AA/%	ADG/(g/d)	ADFI/(g/d)	F/G
Nam et al. [15] (1994)	T3 G2	(Duroc × Hampshire) × (Landrace × Large White)	Yes	10.5	25.0	1.25	1.25	620	980	1.58
Nam et al. [15] (1994)	T3 G3	(Duroc × Hampshire) × (Landrace × Large White)	Yes	10.5	25.0	1.35	1.35	635	1000	1.57
Nam et al. [15] (1994)	T3 G4	(Duroc × Hampshire) × (Landrace × Large White)	Yes	10.5	25.0	1.45	1.45	640	1010	1.58
Williams et al. [25] (1997)	Low G1	Genetiporc	Yes	10.2	24.8	0.95	0.95	520	890	1.71
Williams et al. [25] (1997)	Low G2	Genetiporc	Yes	10.2	24.8	1.05	1.05	560	920	1.64

Literature (published year)	Treatment Group	Genetic background	Antibiotic	Initial weight/kg	Final weight/kg	SID Lys reported in publications/%	Calculated SID AA/%	ADG/(g/d)	ADFI/(g/d)	F/G
Williams et al. [25] (1997)	Low G3	Genetiporc	Yes	10.2	24.8	1.15	1.15	590	940	1.59
Williams et al. [25] (1997)	Low G4	Genetiporc	Yes	10.2	24.8	1.25	1.25	610	960	1.57
Williams et al. [25] (1997)	Low G5	Genetiporc	Yes	10.2	24.8	1.35	1.35	620	970	1.56
Smith et al. [16] (2001)	T2 G1	Commercial crossbred	Yes	11.0	26.5	1.10	1.10	580	940	1.62
Smith et al. [16] (2001)	T2 G2	Commercial crossbred	Yes	11.0	26.5	1.20	1.20	610	960	1.57
Smith et al. [16] (2001)	T2 G3	Commercial crossbred	Yes	11.0	26.5	1.30	1.30	630	980	1.56
Smith et al. [16] (2001)	T2 G4	Commercial crossbred	Yes	11.0	26.5	1.40	1.40	640	990	1.55
Urynek et al. [24] (2003)	T2 G1	PIC C22	Yes	12.5	28.0	1.05	1.05	550	920	1.67
Urynek et al. [24] (2003)	T2 G2	PIC C22	Yes	12.5	28.0	1.15	1.15	580	940	1.62
Urynek et al. [24] (2003)	T2 G3	PIC C22	Yes	12.5	28.0	1.25	1.25	600	960	1.60

Literature (published year)	Treatment Group	Genetic background	Antibiotics	Initial weight/kg	Final weight/kg	SID Lys reported in publications/%	Calculated SID AA/%	ADG/(g/d)	ADFI/(g/d)	F/G
Urynek et al. [24] (2003)	T2 G4	PIC C22	Yes	12.5	28.0	1.35	1.35	610	970	1.59
Xi et al. [27] (2003)	Exp.1	Landrace × Large White	Yes	10.8	25.5	1.18	1.18	595	960	1.61
Qiao [28] (2005)	Exp.1	Camborough	Yes	11.5	27.0	1.22	1.22	605	970	1.60
Yi et al. [20] (2006)	Exp.1	Genetipores	Yes	11.2	26.8	1.25	1.25	615	980	1.59
Abreu et al. [17] (2006)	Exp.1	Genetipores	Yes	15.0	30.0	1.20	1.20	625	990	1.58
Oliveira et al. [22] (2006)	Exp.1	Genetipores	Yes	15.5	30.5	1.28	1.28	640	1000	1.56
Kendall et al. [2] (2008)	Exp.1	Genetipores	Yes	11.0	27.0	1.30	1.30	630	980	1.56
Fraga et al. [18] (2008)	Exp.2	PIC	Yes	15.0	30.0	1.15	1.15	610	960	1.57
Zhu et al. [30] (2009)	LP G1	Lulai synthetic line	Yes	10.5	25.0	1.12	1.12	580	940	1.62
Zhu et al. [30] (2009)	LP G2	Lulai synthetic line	Yes	10.5	25.0	1.22	1.22	610	960	1.57

Literature (published year)	Treatment Group	Genetic background	Antibiotics	Initial weight/kg	Final weight/kg	SID Lys reported in publications/%	Calculated SID AA/%	ADG/(g/d)	ADFI/(g/d)	F/G
Zhu et al. [30] (2009)	LP G3	Lulai synthetic line	Yes	10.5	25.0	1.32	1.32	625	970	1.55
Figueroa et al. [19] (2012)	Exp.2	PIC	Yes	12.0	28.5	1.24	1.24	620	980	1.58
Wang [26] (2014)	Exp.5	Guanzhong Black	Yes	10.0	25.0	1.08	1.08	540	900	1.67
Wang [26] (2014)	Exp.5	Guanzhong Black	Yes	10.0	25.0	1.18	1.18	570	930	1.62
Wang [26] (2014)	Exp.5	Guanzhong Black	Yes	10.0	25.0	1.28	1.28	590	950	1.60
Nieto et al. [21] (2015)	Exp.2	Iberian piglets	No	10.2	24.5	1.06	1.06	425	780	1.84
Yuan et al. [29] (2015)	Trp0.25	Yantai Black	Yes	15.0	30.0	1.14	1.14	580	940	1.62
Pasquetti et al. [23] (2015)	Trp0.25	Genetiporc	Yes	15.0	30.0	1.32	1.32	640	1000	1.56

Note: Figure translations are in progress. See original paper for figures.

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