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Optimum Dietary Standardized Ileal Digestible Isoleucine to Lysine Ratio for Meat-Type Quails in the Growing-Finishing Phase

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ABSTRACT

This study was conducted to determine the optimum standardized ileal digestible isoleucine to lysine (SID Ile:Lys) ratio for meat-type quails from 15 to 35 d of age. Three hundred fifty not-sexed meat-type quails (*Coturnix coturnix coturnix*) were randomly assigned into five treatments, with seven replicates of 10 quails each. An isoleucine-deficient corn-soybean meal-based diet was formulated and graded supplemented with L-isoleucine (99%) to obtain diets containing SID Ile:Lys ratios of 55,61, 67, 73, and 79%. Data were analyzed as one-way ANOVA and optimum SID Ile:Lys was estimated by polynomial (linear and quadratic) regression. Statistical differences were considered when $p<0.05$. Quail performance from 15 and 21 d and 15 and 28 d of age was not affected by the treatments. From 15 to 35 d of age, body weight gain and body weight exhibited a quadratic response to increasing dietary SID Ile:Lys ratios, and were optimized at 66 and 67% SID Ile:Lys, respectively. Feed conversion ratio was not influenced by SID Ile:Lys ratios in any of the phases assessed herein. Based on the results, the optimum SID Ile:Lys ratio for meat-type quails from 15 to 35 d of age is 67%.

INTRODUCTION

The branched-chain amino acids (BCAA) valine (Val), isoleucine (Ile), and leucine (Leu) play an important role on poultry growth, since together they account for35% of muscle proteins. Due to similarities in their molecular structure, branched-chain amino acids share common intestinal transport systems through the enterocyte membranes and are broken down by the same enzymes (Harper, 1984; Broer, 2008). Langer *et al*. (2000) demonstrated that alpha-ketoisocaproate, the α-keto acid derived from leucine transamination, enhances the activity of the branched-chain α-keto acids dehydrogenase complex (BCKDH), resulting in valine and isoleucine catabolism in the liver of pigs.

Isoleucine is reported as the fifth limiting amino acid in diets based on corn and soybean meal, and as the fourth limiting amino acid in broiler diets containing 3% or more protein from animal by-product sources (Corzo *et al*., 2010). Literature data suggest that the SID Ile:Lys ratio for optimal broiler performance during the growing-finishing phase ranges between 67% (Baker *et al*., 1994; Kidd *et al*., 2004) and 68% (Rostagno *et al*., 2011). Unlike broilers, the nutritional requirements of meat-type quail are not completely defined yet. Silva & Costa (2009) propose a 84% SID Ile:Lys ratio for optimum meat-type quail growth, whereas Batista, (2013) estimated an ideal SID Ile:Lys ratio of 46% for growing-finishing meat-type quails.

The supplementation of commercial poultry diets with crystalline amino acids (*e.g.* L-Lys, DL-Met, and L-Thr) has allowed reducing feed costs and nitrogen excretion, without compromising production per-formance. Nevertheless, the application of such approach requires previous knowledge of bird amino acid requirement to avoid insufficient dietary supply. Considering a practical scenario, in which low-protein diets containing animal protein meal are generally used to reduce feed costs, discrepancies about optimum SID Ile:Lys ratio for meat-type quails may limit the application of such nutritional strategy. Therefore, this experiment was conducted to determine the ideal SID Ile:Lys ratio requirements for the optimal performance of meat-type quails form 15 to 35 d of age.

MATERIALS AND METHODS

Animal care and use

The experimental procedures involving animal care and use were previously approved by the institutional Animal Care and Use Committee of the Federal University of Viçosa, Viçosa, Minas Gerais, Brazil.

Bird husbandry and experimental design

From one to 14 d of age, meat-type quails were housed in a controlled-temperature room with concrete floor covered with wood-shavings litter. Diets (mash form) were formulated to Silva & Costa (2009). At 15 d of age, a total of 350 not-sexed quails were housed in a double-curtain sided room, and were randomly allotted to one of five treatments, with seven replicates of 10 birds each. The experimental unit consisted of a 50 x 50 x 30 cm metal cage, equipped with one nipple drinker and one stainless steel self-feeder, with 10 quails each. Diets and water were supplied *ad libitum* throughout the trial. Environmental temperature and humidity were daily measured. Light was supplied 24 hours a day (natural + artificial).

Diets

The experimental diets (Table 1) were formulated to meet or exceed the nutritional requirements recommended by Silva & Costa (2009), except for digestible amino acids requirements. In order to establish the ideal amino acid profile for meat-type quails, previous experiments were conducted to determine SID Met:Lys, SID Thr:Lys, and SID Trp:Lys ratios for optimal meat-type quail performance. Therefore, the basal diet of the current trial was formulated to contain the SID Met:Lys, SID Thr:Lys, and SID Trp:Lys ratios recommended by Ribeiro (2015) and the SID Val:Lys ratio according to Alves *et al*. (2016).

Table 1 – Ingredients and calculated nutritional composition of the experimental diets.

Ingredients	Amount (g/kg)
Corn (7.88%)	724.10
Soybean meal (45.22%)	227.70
Soybean oil	1.14
Limestone	9.29
Dicalcium phosphate	11.16
Salt	3.30
L-Lysine HCl (78.9%)	4.91
DL-Methionine (99%)	4.69
L-Threonine (98.5%)	2.84
L-Tryptophan (99%)	0.32
L-Valine (96.5%)	1.86
L-Isoleucine (99%)	-
Cornstarch	5.00
Mineral premix[1]	1.00
Vitamin premix[2]	1.00
Choline chloride (60%)	0.100
Antioxidant[3]	0.10
Coccidiostat[4]	0.50
Antibiotic[5]	0.10
Calculated composition	
Metabolizable energy (kcal/kg)	3,050
Crude protein (g/kg)	171.0
Calcium (g/kg)	7.00
Available phosphorous (g/kg)	3.00
Sodium (g/kg)	1.50
SID Lysine (g/kg)	11.10
SID Methionine + Cysteine (g/kg)	9.32
SID Threonine (g/kg)	8.33
SID Tryptophan (g/kg)	2.00
SID Valine (g/kg)	8.66
SID Isoleucine (g/kg)	6.11
SID Leucine (g/kg)	14.00

[1]Mineral premix (amount per kg diet): Manganese 160g. Iron 100g. Zinc 100g. Copper 20g. Cobalt: 2g. Iodine: 2g. excipient: 616 g. [2]Vitamin premix (amount per kg diet): Vit. A: 12,000,000 IU, Vit D3: 3.600.000 IU, Vit. E: 3,500 IU, Vit B1: 2,500 mg, Vit B2: 8,000 mg, Vit B6: 5,000 mg, Pantothenic acid: 12,000 mg, Biotin: 200 mg, Vit. K: 3,000 mg, Folic acid: 1,500mg, Nicotinic acid: 40,000 mg, Vit. B12: 20,000 mg, Selenium: 150 mg. Excipient qsp. [3]Butil-hidroxy-toluen. [4] Salinomycin 60%. [5]Avilamycin.

The basal diet was formulated to contain 90% SID Lys (11.10 g/kg), as recommended by Silva & Costa (2009). The ingredient and nutritional composition values used for diet formulation were those described by Rostagno *et al*. (2011). Crystalline L-Ile was supplemented at graded levels (0.000, 0.067, 0.134, 0.201, and 0.269), in replacement of cornstarch in the isoleucine-deficient basal diet to obtain the experimental treatments, which consisted of five SID Ile:Lys ratios (55, 61, 67, 73, and 79%).

Performance parameters

At 21, 28 and 35 d of age, quails and feeders were weighed to determine body weight and feed intake during each phase. Feed intake was divided by weight gain to obtain the feed conversion ratio. Mortality was daily recorded to adjust feed intake and feed conversion ratio.

Statistical analysis

Data were analyzed as one-way ANOVA and the ideal dietary SID Ile:Lys ratio was estimated by polynomial (linear and quadratic) regression analyses. Statistical analyses were performed using the software package Sistemas de Análises Estatísticas e Genéticas (SAEG, 2007). SID Ile:Lys ratio effects were considered significant when $p<0.05$.

RESULTS

The effects of dietary SID Ile:Lys ratios on on meat-type quail performance are presented in Tables 2, 3 and 4. Live performance from 15 to 21 d and 15 to 28 d of age (Tables 2 and 3) was not influenced ($p>0.05$) by the evaluated dietary SID Ile:Lys ratios. However, from 15 to 35 d of age (Table 4), body weight gain and body weight were optimized at 66 and 67% SID Ile:Lys ratios, respectively, according to quadratic regression model ($p<0.05$).Feed conversion ratio was not influenced by the treatments, regardless of rearing phase.

Table 2 – Performance of meat-type quails fed different SID Ile:Lys ratios from 15 to 21 d of age.

SID Ile:Lys (%)	FI (g)	WG (g)	FCR (kg/kg)	BW (g)
55	103.48	45.43	2.28	133.11
61	104.14	45.33	2.30	133.21
67	104.82	45.08	2.23	134.88
73	102.88	46.00	2.24	133.88
79	104.26	46.00	2.27	133.93
CV[1] (%)	1.85	3.11	2.30	1.08
P-Value				
Linear	0.999	0.297	0.184	0.192
Quadratic	0.999	0.201	0.167	0.182

[1]Coefficient of variation

Feed intake (FI), body weight gain (WG), feed conversion ratio (FCR), body weight (BW)

Table 3 – Performance of meat-type quails fed different SID Ile:Lys ratios from 15 to 28 d of age.

SID Ile:Lys (%)	FI (g)	WG (g)	FCR (kg/kg)	BW (g)
55	240.43	90.81	2.65	178.49
61	242.33	91.14	2.66	179.02
67	244.85	93.64	2.62	181.59
73	243.21	92.31	2.63	180.20
79	241.40	91.51	2.64	179.44
CV[1] (%)	2.18	3.77	2.35	1.92
P-Value				
Linear	0.999	0.999	0.999	0.999
Quadratic	0.132	0.222	0.999	0.206

[1]Coefficient of variation

Feed intake (FI), body weight gain (WG), feed conversion ratio (FCR), body weight (BW)

Table 4 – Performance of meat-type quails fed different SID Ile:Lys ratios from 15 to 35 d of age.

SID Ile:Lys (%)	FI (g)	WG (g)	FCR (kg/kg)	BW (g)
55	425.22	136.52	3.11	224.21
61	427.98	139.47	3.07	227.35
67	434.36	141.78	3.06	229.58
73	426.86	137.82	3.10	225.70
79	426.07	136.04	3.13	223.97
CV[1] (%)	2.78	3.69	2.68	2.38
P-Value				
Linear	0.999	0.999	0.999	0.999
Quadratic	0.222	0.037	0.101	0.045

[1]Coefficient of variation

Feed intake (FI), body weight gain (WG), feed conversion ratio (FCR), body weight (BW)

DISCUSSION

As shown in Table 5, dietary SID Ile:Lys ratios of 66 and 67% optimized quails' body weight gain and body weight from 15 to 35 d of age. Campos *et al*. (2012) determined a 72% SID Ile:Lys ratio for optimal weight gain of 28- to 40-d-old broilers. Similarly, Duarte (2015) recommended an optimum SID Ile:Lys ratio for broiler in the growing-finishing phase at 72%.

Table 5 – Regression equations of performance parameters of meat-type quails fed different SID Ile:Lys ratios between 15 and 35 days of age.

Variable	Regression Equation	Estimate	R^2
WG	$3.3845 + 4.1387x – 0,0312x^2$	66.33	0.83
BW	$89.633 + 4.1786x – 0.0314x^2$	66.53	0.84

Weight gain (WG) and body weight (BW)

The SID Ile:Lys ratio requirement for optimal meat-type quail performance determined in the present study is different from the values published in literature. Batista (2013) suggested that the SID Ile:Lys ratio optimum meat-type quail growth was lower than 48%, whereas Silva & Costa (2009) recommend a SID Ile:Lys ratio of 84%. However, the SID Ile:Lys ratio herein determined is close to that recommended by Rostagno *et al*. (2011) for growing-finishing broilers (68%).

Branched-chain amino acids share common transport systems through the enterocyte membranes and are broken down by the same enzymes (Harper, 1984). Studies have shown that low Val and Leu concentrations increase Ile blood levels in laying hens, which are reduced when both amino acids are supplied at high concentrations in the diet (Peganova & Eder, 2003). The dietary SID Val:Lys ratios supplied in the current study were previously determined in quails of the same age. Therefore, it is unlikely that Val influenced Ile metabolism. Nevertheless, the same inference on the effects of the Leu content in the basal diet on Ile metabolism cannot be made.

There are no data in literature on ideal SID Leu:Lys ratios for meat-type quails. However, considering the similarity of the SID Ile:Lys ratios herein estimated for meat-type quail with those recommended by Rostagno *et al*. (2011) for broilers, it is possible that the SID Leu:Lys ratios present the same behavior in both species. The SID Leu:Lys ratio in the basal diet was 126%, which is higher than the 108% described by Rostagno *et al*. (2011) for optimal broiler growth. Taking into account the antagonism among BCAA mentioned above, the Leu content of the basal diet may explain the poorer performance of quails fed diets containing lower SID Ile:Lys ratios.

The margin between Ile requirement and excess is very narrow in laying hens (Peganova & Eder, 2002). Peganova & Eder (2003) reported that increasing dietary Ile supply from 8.0 to 10.0 g/kg reduced layers' feed intake and egg mass (Peganova & Eder, 2002). However, such detrimental effect of excessive dietary Ile levels appears not to be related with the competition between Val and Leu for intestinal absorption. Peganova & Eder (2003) did not observe any deleterious effects of excessive Ile supply on Val and Leu blood levels in laying hens. However, those authors reported that, at high dietary levels, Ile reduced Lys blood concentration. Such negative interaction may explain the body weight gain and body weight reduction observed when dietary SID Ile:Lys ratio increased from 67 to 73% and to 79% respectively, considering that Lys is almost totally used for body protein accretion (Hamid et al., 2015).

Based on the results obtained in the present study, it is concluded that the SID Ile:Lys ratio for meat-type quails from 15 to 35 d of age is 67%.

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