Apparent and standardized ileal amino acid digestibilities of corn, wheat, soybean meal, and corn gluten meal in quail chicks

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ABSTRACT Two experiments were conducted to measure the apparent and standardized ileal digestibilities (AID and SID) of amino acid (AA) of corn, wheat, soybean meal (SBM), and corn gluten meal (CGM) in growing Japanese quail from 14 to 18 (Exp. 1) and 28 to 32 (Exp. 2) d of age. The basal endogenous losses of amino acids were measured by the use of N-free diet. The birds were fed on standard diet before the use of experimental diets. The experimental diets (four ingredients) and N-free diet were randomly assigned to 5 replicate pens (30 birds per pen) and fed for 5 consecutive days. The ileal digesta were collected on d 18 and 32 for the Exp. 1 and Exp. 2, respectively. AID of lysine (Lys) in corn (P = 0.047), SBM (P < 0.001), and CGM (P < 0.001); AID of threonine (Thr) in corn (P < 0.001), SBM (P < 0.001), and CGM (P = 0.075); and AID of isoleucine (Ile) in wheat (P < 0.001), SBM (P = 0.002), and CGM (P < 0.001) were increased as the birds aged. However, AID of methionine (Met) in corn (P < 0.001) and CGM (P < 0.001), AID of arginine (Arg; P < 0.001) and valine (Val; P < 0.001) in CGM were lower in younger quails. Among indispensable amino acids, the basal endogenous losses of Thr, Val, and Arg decreased by age (P < 0.001). The average of SID of Lys, Ile, Met, Val, Thr, Arg, leucine (Leu), and histidine (His) for corn, wheat, SBM, and CGM were estimated as 83, ND, 90.9, 94.3, 90.8, 90.1, 91.9, and 90.8%; 92.7, ND, 89.1, 94.3, 90.4, 90.6, 89.8, and 88.1%; 90.3, 91.8, 94.3, 90.4, 94.0, 94.0, 84.3, and 95.0%; 82.6, ND, 79.6, 84.4, 90.6, 85.2, and 82.4%, respectively. Based on the present study, the AID and SID coefficients of indispensable AA should be adjusted for age classes in Japanese quail during the growing period.

Key words: basal endogenous losses, ileal digestibility, quail

INTRODUCTION

Two main components of poultry diet are the metabolizable energy and protein source, especially the profile of indispensable amino acid (IAA). It has been shown that feed formulation based on apparent ileal amino acid digestibility (AIAAD) is more accurate to supply AA requirements than total amino acid (AA) basis (Rostagno, et al., 1995). The most important problem of feed formulation based on AIAAD coefficients is the lack of additivity of those coefficients in the mixed diet (Kong and Adeola, 2013; Xue, et al., 2014). On the other hand, Osho, et al. (2019) stated that the standardized ileal amino acid digestibility (SIAAD) coefficients of amino acids are more additive than AIAAD coefficients.

ABSTRACT Two experiments were conducted to measure the apparent and standardized ileal digestibilities (AID and SID) of amino acid (AA) of corn, wheat, soybean meal (SBM), and corn gluten meal (CGM) in growing Japanese quail from 14 to 18 (Exp. 1) and 28 to 32 (Exp. 2) d of age. The basal endogenous losses of amino acids were measured by the use of N-free diet. The birds were fed on standard diet before the use of experimental diets. The experimental diets (four ingredients) and N-free diet were randomly assigned to 5 replicate pens (30 birds per pen) and fed for 5 consecutive days. The ileal digesta were collected on d 18 and 32 for the Exp. 1 and Exp. 2, respectively. AID of lysine (Lys) in corn (P = 0.047), SBM (P < 0.001), and CGM (P < 0.001); AID of threonine (Thr) in corn (P < 0.001), SBM (P < 0.001), and CGM (P = 0.075); and AID of isoleucine (Ile) in wheat (P < 0.001), SBM (P = 0.002), and CGM (P < 0.001) were increased as the birds aged. However, AID of methionine (Met) in corn (P < 0.001) and CGM (P < 0.001), AID of arginine (Arg; P < 0.001) and valine (Val; P < 0.001) in CGM were lower in younger quails. Among indispensable amino acids, the basal endogenous losses of Thr, Val, and Arg decreased by age (P < 0.001). The average of SID of Lys, Ile, Met, Val, Thr, Arg, leucine (Leu), and histidine (His) for corn, wheat, SBM, and CGM were estimated as 83, ND, 90.9, 94.3, 90.8, 90.1, 91.9, and 90.8%; 92.7, ND, 89.1, 94.3, 90.4, 90.6, 89.8, and 88.1%; 90.3, 91.8, 94.3, 90.4, 94.0, 94.0, 84.3, and 95.0%; 82.6, ND, 79.6, 84.4, 90.6, 85.2, and 82.4%, respectively. Based on the present study, the AID and SID coefficients of indispensable AA should be adjusted for age classes in Japanese quail during the growing period.

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As far as the authors are aware, the update data on SIAAD in quail are not available for feed formulation of quail chicks and data derived from broiler chickens are the available basis for feed formulation of growing quail chicks. Therefore, the aim of the present study was to measure the AIAAD of corn, wheat, SBM, and CGM and then to estimate the SIAAD coefficients in quail chicks from 14 to 18 and 28 to 32 d of age.

MATERIALS AND METHODS

Bird Management

The Research Animal Ethic Committee of the University of Zabol and Iranian Council of Animal Care approved this experimental protocol. One-day old straight-run quail chicks (Coturnix coturnix Japonica) were provided from the meat-type Quail Genetic Stock Centre at the Research Center of the Research Institute of Zabol (RCRIZ, Sistan, Iran). In Exp 1, a total of 750 quail chicks were randomly allotted to 24 floor pens consisted of 5 treatments with 5 replicates and 30 birds per pen.

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The chicks were fed on grower diet based on the recommendation of NRC (1994) until d 13. At d 14, the birds received experimental diets for 5 d. At d 18, all birds in pen replicates were killed by CO2 asphyxiation and ileal contents were collected. In Exp. 2, the same number of birds in five treatment with 5 replicates and 30 birds per pen were used. The birds received grower diet until d 27. At d 28, the birds were fed on experimental diets for 5 d. At d 32, all birds in pen replicates were killed by CO2 asphyxiation and ileal contents were collected. The temperature of experimental house was set at 26°C in the third weeks of age afterward with relative humidity of 60%. The lighting program was 23L:1D during the study. Birds had ad libitum access to feed and water throughout the study.

**Experimental Diets**

All feed ingredients were analyzed for CP and AA profile before feed formulation (Table 1). A semipurified N-free diet based on cornstarch was used to measure the basal endogenous losses (BEL) of AA and this measurement was then used to estimate SID of AA by correcting AID coefficients for BEL. The remaining 4 treatments in both experiments were formulated based on each ingredient, in which each feed ingredient was the sole source of CP and AA content of the diet (Table 2). Titanium dioxide was added as an indigestible marker at 5 g/kg of diet. All diets were fed in mash form.

**Digesta Sampling**

The ileal digesta (between Meckel’s diverticulum to approximately 1cm proximal to the ileocecal junction) were collected by gently flushing with distilled water into plastic containers and samples within a pen were pooled, frozen, and stored at −20°C until further processing. Samples were freeze-dried, ground by the use of a mortar and pestle, and submitted to the laboratory for amino acid and titanium analysis.

| Table 1. Concentration of amino acids in test ingredients (% as is basis). |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| Dry matter      | 88.1            | 92.7            | 92.3            | 95.1            |
| Crude protein   | 8.80            | 11.9            | 46.9            | 61.0            |
| Methionine      | 0.177           | 0.186           | 0.641           | 1.393           |
| Lysine          | 0.244           | 0.351           | 2.872           | 0.928           |
| Threonine       | 0.299           | 0.336           | 1.862           | 1.911           |
| Tryptophan      | 0.063           | 0.140           | 0.636           | 0.323           |
| Valine          | 0.395           | 0.501           | 2.292           | 2.630           |
| Arginine        | 0.402           | 0.581           | 3.375           | 1.812           |
| Isoleucine      | 0.282           | 0.305           | 2.212           | 2.298           |
| Leucine         | 0.987           | 0.776           | 3.655           | 9.255           |
| Histidine       | 0.243           | 0.278           | 1.244           | 1.165           |
| Glutamic acid   | 1.348           | 3.500           | 8.785           | 12.657          |
| Aspartic acid   | 0.538           | 0.609           | 5.462           | 3.480           |
| Serine          | 0.400           | 0.534           | 2.404           | 2.833           |
| Glycine         | 0.330           | 0.474           | 2.049           | 1.579           |
| Alanine         | 0.614           | 0.424           | 2.092           | 4.988           |
| Proline         | 0.744           | 0.140           | 2.430           | 5.152           |

**Chemical Analysis**

As described by Hasanvand et al. (2018), feed samples were prepared using a 24-h hydrolysis in 6 N hydrochloric acid at 110°C under an atmosphere of nitrogen. For Met and Cys, performic acid oxidation was done before acid hydrolysis. Samples for Trp analysis were hydrolyzed using barium hydroxide. Chromatographic separations of amino acids were performed with a Waters HPLC system (Waters, Milford, MA). It consisted of a 1525 Binary HPLC pump, a 2,487 Dual λ absorbance detector operating at 254 nm, Breeze chromatography software and a Rheodyne 7725 injection valve (Cotati, CA) which equipped with a 20 μL sample loop. The column was Pico tag (3.9 × 150 mm I.D.; particle size 5 μm). Titanium dioxide was determined by hydrolysis of the sample with sulphuric acid (H2SO4) followed by a color reaction as described by Short et al. (1996).

**Calculations**

The BEL, AID, and SID coefficients of AA were calculated according to Adedokun et al. (2008):

\[
BEL (mg/kgDMI) = \text{amino acid in ileal digesta (mg/kg)} \times \text{diet titanium (mg/kg)} \div \text{ileal titanium (mg/kg)}
\]

\[
AIAAD_\% = \left[1 - \left(\frac{\text{titanium in diet}}{\text{titanium in ileal digesta}}\right) \times \left(\frac{\text{amino acid in digesta}}{\text{amino acid in diet}}\right)\right] \times 100
\]

\[
SIAAD_\% = AIAAD_\% + \left(\frac{\text{BEL (mg/kgDMI)}}{\text{amino acid content of raw material (mg/kgDMI)}}\right) \times 100
\]

**Statistical Analysis**

Data were analyzed by using PROC GLM of SAS (2002) as a completely randomized design. Effect of age on BEL, AIAAD and SIAAD values was determined. The level of significance was set at P < 0.05.

**RESULTS**

No mortality was observed during the study and the quail performance was shown in Table 3. In Exp. 1, the highest performance was observed in the birds fed on wheat (P < 0.001). In Exp. 2, the birds fed on SBM had the highest gain and gain:feed compared to the other groups (P < 0.001). In both experiments, the birds fed on N-free diet had the lowest performance compared to the other groups (P < 0.001). Digestibility coefficients were feed and age-dependent. AIAAD and SIAAD
coefficients of AA for corn, wheat, SBM, and CGM at 2 different classes’ age were shown in Tables 4−7.

As shown in Figure 1, basal endogenous losses of Thr ($P < 0.001$), Val ($P < 0.001$), and Arg ($P = 0.043$) were decreased by age, while the decreasing changes of the remaining indispensable AA were not significant.

For corn, at wk 3, the lowest and highest SIAAD coefficients were determined for aspartic acid (Asp) and His, respectively. At wk 5, the corresponding values were determined for glycine (Gly) and Thr, respectively. The AID of Lys ($P = 0.047$) and Thr ($P < 0.001$) were increased by age while the AID of Met ($P < 0.001$) was decreased with increasing age (Figure 2). The average of AID and SID of the studied AA were shown in Table 8.

For wheat, at wk 3, the lowest and highest SIAAD coefficients were determined for Asp and Lys, respectively. At wk 5, the corresponding values were determined for Ala and Lys + Val, respectively. AID of Lys ($P < 0.001$), Thr ($P < 0.001$), Ile ($P = 0.002$), and Val ($P < 0.001$) increased with increasing age (Figure 2).

For CGM, at wk 3, the lowest and highest SIAAD coefficients were determined for Thr and His, respectively. At wk 5, the corresponding values were determined for Ala and Lys + Val, respectively. AID of Lys ($P < 0.001$), Thr ($P < 0.001$), Ile ($P = 0.002$), and Val ($P < 0.001$) increased with increasing age (Figure 2).

**DISCUSSION**

Because of scanty data on AA digestibility in quail, we have to compare our data with that reported Garcia et al. (2007) and Kim et al. (2012) by on broiler and rooster.

For corn, the comparison our data with Garcia et al. (2007) showed that SID coefficients of almost all tested
Table 4. Estimated marginal means of apparent and standardized ileal amino acid digestibility (AIAAD and SIAAD) of corn in quail chicks at two different age classes (n = 150).

| Amino acid (AA) | AIAAD (%) | SIAAD (%) |
|----------------|-----------|-----------|
|                | I         | II        | I         | II        |
| Indispensable  |           |           |           |           |
| Lysine         | 70.2      | 79.7      | 84.0      | 82.0      |
| Isoleucine     | 75.6      | 79.3      | 92.2      | ND        |
| Methionine     | 92.4      | 81.5      | 94.5      | 84.2      |
| Valine         | 84.8      | 84.6      | 93.9      | 85.7      |
| Threonine      | 79.8      | 95.4      | 88.3      | 95.8      |
| Arginine       | 87.0      | 89.8      | 89.8      | 90.6      |
| Histidine      | 94.3      | 83.3      | 97.5      | 84.0      |
| Disposable     |           |           |           |           |
| Glutamic acid  | 89.2      | 79.3      | 90.2      | 80.2      |
| Aspartic acid  | 71.4      | 94.1      | 74.3      | 94.6      |
| Leucine        | 93.6      | 88.9      | 94.1      | 89.8      |
| Serine         | 84.6      | 83.3      | 86.9      | 84.0      |
| Glycine        | 91.2      | 70.4      | 92.1      | 70.5      |
| Alanine        | 90.8      | 82.4      | 91.1      | 85.3      |
| Proline        | 95.9      | 65.1      | 96.2      | 66.3      |
| Pooled SEM     | 1.50      | 1.06      | 1.57      | 1.11      |

Table 5. Estimated marginal means apparent and standardized ileal amino acid digestibility (AIAAD and SIAAD) of wheat in quail chicks at two different age classes (n = 150).

| Amino acid (AA) | AIAAD (%) | SIAAD (%) |
|----------------|-----------|-----------|
|                | I         | II        | I         | II        |
| Indispensable  |           |           |           |           |
| Lysine         | 86.5      | 88.5      | 95.5      | 90.0      |
| Isoleucine     | 79.5      | 85.7      | ND        | ND        |
| Methionine     | 90.8      | 83.8      | 92.5      | 94.5      |
| Valine         | 88.3      | 85.0      | 94.7      | 93.0      |
| Threonine      | 82.0      | 81.5      | 89.8      | 92.9      |
| Arginine       | 84.3      | 76.7      | 88.5      | 92.0      |
| Histidine      | 81.2      | 88.8      | 91.2      | 92.1      |
| Disposable     |           |           |           |           |
| Glutamic acid  | 74.3      | 73.9      | 86.7      | 90.2      |
| Aspartic acid  | 71.4      | 92.9      | 84.0      | 95.4      |
| Leucine        | 78.0      | 92.9      | 84.2      | 95.4      |
| Serine         | 89.3      | 90.0      | 90.8      | 94.2      |
| Glycine        | 84.1      | 88.8      | 92.1      | 94.1      |
| Alanine        | 93.0      | 76.4      | 95.2      | 93.3      |
| Proline        | 93.5      | 70.0      | 94.3      | 89.6      |
| Pooled SEM     | 2.12      | 1.50      | 2.15      | 1.52      |

Table 6. Estimated marginal means of apparent and standardized ileal amino acid digestibility (AIAAD and SIAAD) of soybean meal in quail chicks at two different age classes (n = 150).

| Amino acid (AA) | AIAAD (%) | SIAAD (%) |
|----------------|-----------|-----------|
|                | I         | II        | I         | II        |
| Indispensable  |           |           |           |           |
| Lysine         | 82.0      | 97.5      | 83.1      | 97.6      |
| Isoleucine     | 85.3      | 95.5      | 87.8      | 95.7      |
| Methionine     | 94.7      | 92.7      | 95.3      | 93.2      |
| Valine         | 81.5      | 97.4      | 83.1      | 97.6      |
| Threonine      | 80.1      | 91.5      | 81.5      | 92.8      |
| Arginine       | 91.1      | 96.5      | 91.5      | 96.6      |
| Histidine      | 95.2      | 93.9      | 95.9      | 94.1      |
| Disposable     |           |           |           |           |
| Glutamic acid  | 90.5      | 87.8      | 90.6      | 88.5      |
| Leucine        | 80.5      | 86.6      | 81.9      | 86.7      |
| Serine         | 89.4      | 94.5      | 89.7      | 94.6      |
| Glycine        | 93.3      | 95.0      | 93.5      | 95.2      |
| Alanine        | 86.8      | 82.1      | 87.0      | 82.9      |
| Proline        | 95.3      | 87.6      | 95.4      | 88.4      |
| Pooled SEM     | 1.79      | 1.27      | 1.76      | 1.25      |

Table 7. Estimated marginal means of apparent and standardized ileal amino acid digestibility (AIAAD and SIAAD) of corn gluten meal in quail chicks at two different age classes (n = 150).

| Amino acid (AA) | AIAAD (%) | SIAAD (%) |
|----------------|-----------|-----------|
|                | I         | II        | I         | II        |
| Indispensable  |           |           |           |           |
| Lysine         | 67.8      | 93.8      | 71.2      | 93.9      |
| Isoleucine     | 63.1      | 95.2      | ND        | ND        |
| Methionine     | 86.0      | 61.6      | 86.3      | 61.9      |
| Valine         | 83.7      | 74.0      | 85.1      | 74.2      |
| Threonine      | 76.8      | 90.6      | 78.0      | 90.7      |
| Arginine       | 89.5      | 90.9      | 90.1      | 91.0      |
| Histidine      | 67.5      | 90.3      | 74.4      | 90.5      |
| Disposable     |           |           |           |           |
| Glutamic acid  | 86.8      | 88.6      | 86.9      | 89.1      |
| Leucine        | 76.2      | 93.6      | 78.2      | 94.1      |
| Serine         | 94.4      | 71.8      | 94.7      | 73.8      |
| Glycine        | 78.2      | 93.0      | 78.5      | 93.8      |
| Alanine        | 83.1      | 89.7      | 84.1      | 90.1      |
| Proline        | 85.7      | 93.1      | 87.7      | 93.4      |
| Pooled SEM     | 3.11      | 2.20      | 3.27      | 2.32      |

| Probability   | AA        | Age       | AA × Age  |
|               |           |           |           |
|               | < 0.001   | < 0.001   | < 0.001   |

I: 14 to 18 d of age; II: 28 to 32 d of age; ND: not determined.

AA in 18 d quail were higher than those reported for 7-day-old broilers. The SID of Ile, Thr, and Leu were 36, 18, and 17% higher than those reported for 7-day-old broilers. The SID of Thr, Leu, and Asp in 32-day-old quail were 28, 12, and 24% higher than those reported for 7-day-old broilers (Figure 3). It was clearly that growing quail was more efficient than broiler and rooster to digest tested AA, which was in agreement with Vasan et al. (2008) who showed that almost all indispensable AA of corn in quail had higher digestibility values than rooster. As shown in Figure 3, the AA digestibilities in 32-day-old quail were comparable with adult rooster.

The differences between AA digestibility values of wheat in quail chicks and broiler were very higher than those reported for corn. The SID of Lys, Met, Val, Thr, Asp, Ser, and Ala in 18-day-old quail were 66, 42, 36, 63, 69, 28, and 64% higher than those in 7-d old broilers and the corresponding values in 32-day-old quail were 56, 45, 33, 69, 92, 33, and 61% higher than those in 7 d old broilers. The SID of Met, Asp, and Ala in 32-day-old quail were 21, 53, and 26% higher than 21-day-old broilers. These differences between quail and 21-day-old broilers and rooster were relatively lower than those
between younger quails and broilers (Figure 3). Although Garcia et al. (2007) reported that the digestibility coefficients for all AA in tested ingredients were significantly lower at 7-day-old broilers than adult roosters, the comparison our data showed that young quails had higher efficiency to digest AA than roosters.

The comparison our data for SBM with that reported by Garcia et al. (2007) revealed that 18-day-old quail had higher digestibilities for all tested AA than 7-day-old broilers, in which the SID of Lys, Ile, Met, Val, Thr, Arg, Leu, His, Glu, Ser, and Ala in 18-day-old quail were 15, 20, 37, 16, 21, 15, 14, 21, 19, 32, and 32% higher than 7-day-old broilers. Digestibility values in 18-day-old quail and roosters were comparable. In 32-day-old quail, the corresponding values were 35, 31, 34, 36, 37, 21, 20, 19, 16, 39, and 39% higher than those in 7-day-old broilers. However, the SID of the all AA in 32-day-old quail was lower than those in roosters (Figure 3).

The SIAAD coefficients of CGM in quail were compared with data of 21-day-old broiler reported by Kim, et al. (2012). Digestibilities of almost all tested AA in 18-day-old quail were lower than those in 21-day-old broilers (Figure 4). The SID of tested AA in 32-day-old quail was higher or comparable with 21-day-old broilers with exception of Met and Ser. The SID of Lys and Thr in 32-day-old quail were 15 and 8% higher than broilers.

**Figure 1.** Basal endogenous losses of some indispensable amino acids (e.g., Lys: lysine; Met: methionine; Val: valine; Thr: threonine; Arg: arginine; Leu: leucine; His: histidine) at two different age classes.

**Figure 2.** Sharp changes in apparent ileal digestibility of lysine, threonine, valine, isoleucine, and arginine of corn, wheat, soybean meal (SBM), and corn gluten meal (CGM) with increasing age in quail chicks.
Table 8. The average of apparent and standardized ileal amino acid digestibility (AIAAD and SIAAD; %) of corn, wheat, soybean meal (SBM), and corn gluten meal (CGM) in quail chicks.

| Amino acid | Corn (AIAAD) | Corn (SIAAD) | Wheat (AIAAD) | Wheat (SIAAD) | SBM (AIAAD) | SBM (SIAAD) | CGM (AIAAD) | CGM (SIAAD) |
|------------|--------------|--------------|---------------|---------------|-------------|-------------|-------------|-------------|
| Indispensable |              |              |               |               |             |             |             |             |
| Lysine     | 75.8         | 83.0         | 87.5          | 92.7          | 89.7        | 90.3        | 80.8        | 82.6        |
| Isoleucine | 77.4         | ND           | 87.0          | ND            | 90.4        | 91.8        | 78.2        | ND          |
| Methionine | 87.0         | 89.4         | 90.6          | 93.9          | 89.5        | 90.4        | 78.9        | 79.6        |
| Valine     | 84.7         | 89.8         | 82.1          | 87.4          | 85.8        | 86.5        | 83.7        | 84.4        |
| Threonine  | 87.6         | 92.1         | 88.5          | 90.2          | 93.8        | 94.0        | 90.2        | 90.6        |
| Arginine   | 88.4         | 90.2         | 85.4          | 89.8          | 83.5        | 84.3        | 84.9        | 85.2        |
| Leucine    | 91.2         | 91.9         | 85.0          | 88.1          | 94.6        | 95.0        | 78.9        | 82.4        |
| Histidine  | 88.8         | 90.8         | 81.8          | 85.0          | 91.5        | 91.9        | 89.4        | 89.6        |
| Dispensable |              |              |               |               |             |             |             |             |
| Glutamic acid | 84.3       | 85.2         | 78.9          | 80.5          | 89.1        | 89.6        | 87.7        | 88.0        |
| Aspartic acid | 82.7       | 84.4         | 82.1          | 84.9          | ND          | ND          | ND          | ND          |
| Serine     | 84.0         | 85.5         | 91.7          | 92.5          | 91.9        | 92.2        | 83.1        | 83.2        |
| Glycine    | 80.8         | 83.1         | 90.0          | 91.1          | 94.1        | 94.2        | 85.6        | 85.8        |
| Alanine    | 80.4         | 88.2         | 91.9          | 94.2          | 84.5        | 85.0        | 86.4        | 86.6        |
| Proline    | 79.5         | 81.2         | 81.8          | 85.0          | 91.5        | 91.9        | 89.4        | 89.6        |
| SEM        | 1.01         | 0.96         | 1.30          | 0.89          | 1.10        | 1.08        | 1.91        | 2.01        |

ND: not determined.

Figure 3. Relative standardized ileal digestibility (SID) of amino acids (AA) of corn, wheat, and soybean meal in quail to those in broiler and rooster as reported by Garcia et al. (2007).
The present data revealed that digestibility values of AA were dependent on feed ingredient and specific AA, quail chick had a higher ability for digestion and digests of AA than broilers, particularly for corn, wheat, and CGM. More studies are warranted in the field of feed assessment for quail, especially in terms of AA digestibilities.

**DISCLOSURES**

The authors whose names are listed immediately below certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or nonfinancial interest (such as personal or professional relationships, affiliations, knowledge, or beliefs) in the subject matter or materials discussed in this manuscript.

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