Digestible Lysine Requirement of Arian Male and Female Broiler Chicks During Six to Twenty-one Days of Age

M. Zaghari\textsuperscript{1}, M. Shivazad\textsuperscript{1}, A. Kamyab\textsuperscript{1} and A. Nikkah\textsuperscript{1}

ABSTRACT

An experiment was conducted to determine the dietary digestible lysine requirement of male and female broiler chickens (Arian) during the period from 6 to 21 days post-hatching. An amino acid-fortified basal diet containing corn and soybean meal as intact protein sources provided 20% CP, and 3200 kcal AMEn/kg. In this experiment 150 male and 150 female chicks were allocated on the basis of BW to 12 treatments in a factorial arrangement (two sexes at six digestible lysine levels) with five replications of five chicks each in a completely randomized design (CRD). The digestible lysine levels fed were 0.85, 0.95, 1.05, 1.15, 1.25 and 1.35%. The growth rate and feed efficiency of birds fed the basal diet fortified with a surfeit level of L-Lysine-HCl were equal to those of birds fed a corn-soybean meal positive control diet. Average body-weight gain (ABWG) and gain: feed (GF) responded quadratically (P<0.05) to incremental dietary lysine addition. Subjecting the growth data to broken-line analysis indicated that the digestible lysine requirement for maximum body weight gain was 1.075% for males and 1.049% for females. The lysine requirement for maximum feed efficiency was 1.179% for males and 1.149% for females. Male chicks required a higher level of dietary lysine than females for both maximal ABWG and GF. Regardless of sex, 8.8% more digestible lysine (percentage of diet) was required for maximal GF than that needed for maximal ABWG.

Keywords: Broiler chickens, Digestible amino acid, Lysine requirement.

INTRODUCTION

Diet formulation on a digestible amino acid basis should more consistently meet the animals' amino acid requirements than those based on total amino acid concentration. The principle, attributable to the fact that nutrients in feedstuffs are recognized to be incompletely digested and metabolized by animals, has been applied widely in the field of energy metabolism. Indeed formulation of diets based on total amino acid concentrations is analogous to formulating poultry diets based on gross energy rather than metabolizable energy.

The benefits of formulating diets based on amino acid digestibility or availability have been documented in research studies with various poultry (Fernandez et al., 1995; Michele and Parsons, 1999; Kamyab and Firman, 2000). The performance of chicks was depressed when soybean meal or feather meal were substituted for crystalline amino acids in diets containing equal levels of total amino acids (Smith, 1968). Similar results were observed when sunflower, rapeseed or cottonseed meal were substituted for soybean meal in practical diets (Green, 1986; Parsons, 1992). Formulation of diets containing these ingredients on an equal digestible amino acid basis resulted in much improved performance that was often similar to the performance obtained from the control of reference diets.

Determination of digestible amino acids composition of feedstuffs and accurate requirement estimates for digestible amino acids are critical in attempts to apply the concept of amino acid availability in formulating a broiler diet. Lysine is often one of
the limiting amino acids in broiler diets (Han and Baker, 1994). As such, it is used as the reference amino acid to which all other indispensable amino acids are ratioed in the ideal amino acid pattern (Baker and Han, 1994). However, good information on digestible or bioavailable lysine requirements of broilers is still very limited. The objective of the present investigation was to determine requirements of digestible lysine for male and female broilers from one to three weeks of age.

**MATERIALS AND METHODS**

**General**

In this experiment, chicks were fed a standard corn-soybean meal starter diet (containing 1.1 % Lys, 3200 kcal AME₉/kg) and kept in a temperature-controlled building on floor from day 0 to 5 days posthatch. On the day sixth posthatch, chicks were held four hours without feed then individually weighed, wing banded, and assigned to diets

**Table 1. Composition of basal diets**

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>56.70</td>
</tr>
<tr>
<td>Soybean meal (CP 46.3 %)</td>
<td>26.41</td>
</tr>
<tr>
<td>Monocalcium phosphate</td>
<td>1.59</td>
</tr>
<tr>
<td>Oyster shells</td>
<td>1.60</td>
</tr>
<tr>
<td>Vitamin premix</td>
<td>0.25</td>
</tr>
<tr>
<td>Mineral premix</td>
<td>0.25</td>
</tr>
<tr>
<td>DL-Methionine</td>
<td>0.49</td>
</tr>
<tr>
<td>L-Threonine</td>
<td>0.35</td>
</tr>
<tr>
<td>L-Tryptophan</td>
<td>0.04</td>
</tr>
<tr>
<td>L-Isoleucine</td>
<td>0.26</td>
</tr>
<tr>
<td>L-Leucine</td>
<td>0.05</td>
</tr>
<tr>
<td>L-Arginine</td>
<td>0.34</td>
</tr>
<tr>
<td>L-Valine</td>
<td>0.34</td>
</tr>
<tr>
<td>L-Histidine</td>
<td>0.04</td>
</tr>
<tr>
<td>Experimental supplements</td>
<td>11.29</td>
</tr>
</tbody>
</table>

**Calculated Analysis**

- AME₉ , kcal/kg: 3200
- Nitrogen: 3.2
- Lysine: 0.85
- Methionine+Cystine: 0.97
- Threonine: 0.90
- Tryptophan: 0.22
- Isoleucine: 0.90
- Leucine: 1.47
- Arginine: 1.47
- Histidine: 0.47
- Valine: 1.04
- Phenylalanine+Tyrosine: 1.42
- Calcium: 1.00
- Available phosphorus: 0.45

1. As-fed basis.
2. Calculated amino acid composition is reported on a digestible amino acid basis.

*a* Vitamin premix provided the following per kilogram of diet: Vitamin A, 9000IU; Cholecalciferol, 2000IU; Vitamin E, 18IU; Vitamin k₃, 4mg; Vitamin B₁₂, 0.015mg; Biotin, 0.15mg; Folic acid, 1mg; Niacin, 30mg; Pantothenic acid, 25mg; Pyridoxine, 2.9mg; Riboflavin, 6.6mg; Thiamine 1.8mg.

*b* Mineral premix provided the following per kilogram of diet: Copper (as cupric sulfate 5H₂O), 10mg; Iodin (as calciumiodate), 0.99mg; Iron (as ferrous sulfate 7H₂O), 50mg; Manganese (as manganese oxide), 99mg; Selenium (as sodium selenite), 0.2mg; Zinc (as zinc oxid), 84mg.

*c* See Table 2.
Laboratory reared Arian male and female broiler chicks. In this experiment one hundred and fifty male and one hundred and fifty female chicks were allocated to 12 treatments (two sexes at six digestible lysine levels) with five replicates of five chicks per replicate in a completely randomized design (CRD) in a factorial arrangement. The initial body weight averaged 125g for both male and female chicks. Additionally a positive control corn-soybean meal (PC) diet (standard starter diet) was fed as a treatment, but data from the PC diet were not included in the statistical analysis. The dietary digestible lysine levels were 0.85, 0.95, 1.05, 1.15, 1.25 and 1.35% (Tables 1 and 2). All diets contained the same amounts of corn and soybean meal, while various amounts of L-Lysine-HCl were substituted for isonitrogenous amounts of L-Glutamic acid. Changes in the dietary ingredients make sure that all diets were isoenergetic, isonitrogenous and equal in electrolyte balance (Na + K - Cl). All diets met an ideal amino acid ratio recommended by Illinois (Baker, 1997) for all other indispensable amino acids for chicks from 0 to 21 days old as determined for the level of 1.35% digestible lysine.

**Experimental Design**

An experiment was conducted to determine the lysine requirement of Arian male and female broiler chicks. In this experiment one hundred and fifty male and one hundred and fifty female chicks were allocated to 12 treatments (two sexes at six digestible lysine levels) with five replicates of five chicks per replicate in a completely randomized design (CRD) in a factorial arrangement. The initial body weight averaged 125g for both male and female chicks. Additionally a positive control corn-soybean meal (PC) diet (standard starter diet) was fed as a treatment, but data from the PC diet were not included in the statistical analysis. The dietary digestible lysine levels were 0.85, 0.95, 1.05, 1.15, 1.25 and 1.35% (Tables 1 and 2). All diets contained the same amounts of corn and soybean meal, while various amounts of L-Lysine-HCl were substituted for isonitrogenous amounts of L-Glutamic acid. Changes in the dietary ingredients make sure that all diets were isoenergetic, isonitrogenous and equal in electrolyte balance (Na + K - Cl). All diets met an ideal amino acid ratio recommended by Illinois (Baker, 1997) for all other indispensable amino acids for chicks from 0 to 21 days old as determined for the level of 1.35% digestible lysine.

**Statistical Analysis**

Data from this experiment was subjected to ANOVA procedures appropriate for completely randomized designs by using the
Table 3. Growth performance of chicks fed six levels of lysine.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Lysine level (%)</th>
<th>ABWG</th>
<th>GF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(g: g)</td>
<td>(g: g)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>0.85</td>
<td>449(^b)</td>
<td>0.647(^c)</td>
</tr>
<tr>
<td></td>
<td>0.95</td>
<td>474(^bc)</td>
<td>0.655(^bc)</td>
</tr>
<tr>
<td></td>
<td>1.05</td>
<td>493(^bc)</td>
<td>0.699(^bc)</td>
</tr>
<tr>
<td></td>
<td>1.15</td>
<td>506(^a)</td>
<td>0.712(^a)</td>
</tr>
<tr>
<td></td>
<td>1.25</td>
<td>494(^a)</td>
<td>0.723(^a)</td>
</tr>
<tr>
<td></td>
<td>1.35</td>
<td>497(^a)</td>
<td>0.719(^a)</td>
</tr>
<tr>
<td>SEM</td>
<td></td>
<td>6.1</td>
<td>0.008</td>
</tr>
<tr>
<td>Female</td>
<td>0.85</td>
<td>449(^b)</td>
<td>0.655(^b)</td>
</tr>
<tr>
<td></td>
<td>0.95</td>
<td>455(^a)</td>
<td>0.665(^a)</td>
</tr>
<tr>
<td></td>
<td>1.05</td>
<td>479(^a)</td>
<td>0.661(^a)</td>
</tr>
<tr>
<td></td>
<td>1.15</td>
<td>471(^a)</td>
<td>0.687(^a)</td>
</tr>
<tr>
<td></td>
<td>1.25</td>
<td>477(^a)</td>
<td>0.694(^a)</td>
</tr>
<tr>
<td></td>
<td>1.35</td>
<td>466(^a)</td>
<td>0.661(^a)</td>
</tr>
<tr>
<td>SEM</td>
<td></td>
<td>5.7</td>
<td>0.006</td>
</tr>
</tbody>
</table>

1 Means within a column with no common superscript differ significantly.
2 ABWG = average body weight gain.
3 GF = gain : feed.

General Linear Models (GLM) procedure of SAS software (SAS Institute, 1985). Digestible lysine requirements for body weight gain and feed efficiency were estimated by one-slope broken-line regression models (Robbins, 1986).

RESULTS

Weight gain and gain: feed ratio of male and female broilers responded quadratically (P<0.05) to incremental dietary lysine addition (Table 3). Male chick grew faster than female (P<0.05). Feed efficiency (Table 3) was higher for male birds than for female birds (P<0.05). No significant (P>0.05) interaction by sex of lysine level was observed for weight gain or feed efficiency. Fitted broken lines (Figure 1) indicated break points at 1.075% and 1.179 % digestible lysine for male weight gain and feed efficiency respectively, and at 1.049% and 1.149 % in female (Figure 2).

DISCUSSION

The translation of digestible lysine requirement of mixed-sex feeding, estimated according to data obtained from present research to total lysine, indicates that the total lysine requirement of broilers is about 1.18% and 1.29% for maximum gain and feed efficiency respectively. These findings indicated that the lysine requirement as estimated by NRC (1994) for 0 to 3-week old broilers which is equal to 1.1 % may be low. These results are in agreement with data reported by Han and Baker (1991, 1993), Baker and Han (1994) and Kidd et al. (1997).

Chicks fed diets containing 0.95 % di-
Digestible lysine had higher average body weight gain and gain: feed ratios than chicks fed a diet containing 0.85 % digestible lysine. Fortifying the basal diet with a surfeit level of lysine not only resulted in substantial improvement in body weight gain and feed efficiency but also yielded growth performance equal to those birds fed a positive control corn-soybean meal (CP) diet. This data indicates that the lysine content of the basal diet was low enough to generate useful lysine response curves (Table 1).

The lysine requirement estimates obtained from the broken-line regression models (Figures 1, 2) suggested a higher requirement for male than for females. Other studies (Huncher and Thomas, 1976; Kessler and Thomas, 1976) have suggested that arginine and tryptophan requirements for males are greater than those for females from 4 to 7 weeks posthatching. It seems logical that male broilers would require higher levels of amino acid than females, because male chicks contain more protein and less fat in their weight gain from both 0 to 3 weeks and 3 to 6 weeks posthatching (Kubena et al., 1974; Hurwitz et al., 1980; Han and Baker, 1991).

The fitted broken-lines (Figures 1 and 2) suggested that body weight gain appeared to plateau at lysine levels considerably below those required for feed efficiency. In other words, 8.8% more digestible lysine (percentage of diet) was required for maximal feed efficiency than that needed for maximal weight gain. Maximal voluntary feed intake generally occurs at the dose allowing for maximal gain. As doses are increased beyond the levels needed for maximal gain, feed intake decreased while gain remained constant.

Most poultry nutritionists agree that a digestible lysine level near to 1.15% and 1.06 % of the diet maximized feed efficiency and weight gain respectively (Han and Baker, 1991, 1993; Knowles and Southern, 1998). Therefore an existing matrix of total amino acid requirements should be converted to digestible amino acid and use in practical feed formulation.

ACKNOWLEDGEMENT

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REFERENCES


ليب زين قابل هضم مورد نياز جوجه هاي گوشتی نر و ماده آرين در مرحله 6 تا 21 روزگي

م. زاغري، م. شيوازاد، ع. بر. كامیاب و غ. نيكخواه

چکیده
آزمایشی در ارتباط با تعیین نیاز لیزین قابل هضم جوجههای گوشتی نر و ماده (آرين) در طی دوره 6 تا 21 روزگي، بعد از تعیین انجام شد. جیره یا به شکل اسیدهای آمینه مصنوعی نیز و کنجاله سویا بعنوان منبع طبیعی پروتئین و حاوی 20% پروتئین خام و 300 کیلو کالری انرژی قابل تبدیلی در هر کیلوگرم بود. در این آزمایش تعداد 150 قطعه جوجه نر نحو 150 قطعه جوجه ماده بر اساس وزن اولیه در قابل طرح کامل تصادفی بصورت فاکتوریل به 12 تیمار (۲ جنس × 6 سطح لیزین قابل هضم) و 5 تکرار که هر تکرار شامل 5 جوجه بود اختصاص داده شدند. سطوح لیزین قابل هضم جنس نر 30%، %/1/5/1/7/5/0/0/5 و 70/85 بود. سرعت رشد و بارزه غذایی جوجه هایی که جیره یا به علاوه اسیدهای آمینه را مصرف نموده بودند معادل گرود کنترل که جیره یا به علاوه اسیدهای آمینه را مصرف نموده بودند بود. رابطه درجه دوم بین میانگین افزایش وزن بدن و بهبود غذایی در مقابل افزایش سطح لیزین قابل هضم جیره مشاهده شد (P<0/05). با استفاده از آنالیز تابعی خش شکسته نیاز لیزین قابل هضم برای حداکثر افزایش وزن در جوجه های نر و و 0/175 و در جوجه هایی ماده 1/6/0/049/1/7/6% تعیین گردید. میزان نیاز برای حداکثر افزایش وزن و بارزه غذایی با محاسبه جوجه های نر و 0/0/1/1 و 0/149/1/0 بود. نیاز جوجه های نر برای حداکثر افزایش وزن و بارزه غذایی به‌طور کلی برای حداکثر افزایش وزن و بارزه غذایی بیشتر از ماده ها بود. صرف نظر از جنسیت میزان نیاز لیزین قابل هضم برای حداکثر افزایش وزن و بارزه غذایی بیشتر از مقدار برای حداکثر افزایش وزن بود.