Lysine nutritional requirements of broilers reared in clean and dirty environments during the pre-starter and starter phases

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ABSTRACT - A total of 3,760 Ross male broiler chicks were used in two trials, one in the pre-starter (1-11 days) phase and the other in the starter (12-22 days) phase. Birds were distributed in a completely randomized experimental design with a factorial arrangement of 5 digestible lysine levels × 2 environments (clean and dirty environment), with eight replicates per treatment. The following dietary digestible lysine levels used were: 1.06, 1.12, 1.18, 1.24 and 1.30% in the pre-starter phase, and 1.00, 1.06, 1.12, 1.18 and 1.24% in the starter phase. Minimal relation of digestible lysine:digestible methionine + cystine, threonine, tryptophan and arginine (72, 67, 19 and 108%, respectively) were maintained, as well as 2.088 and 2.002% of glycine+serine in the pre-starter and starter diets, respectively. Weight gain, feed intake and feed conversion were evaluated. In all phases, dietary digestible lysine levels significantly influenced broiler performance, and broilers reared in the clean environment presented better performance than those reared in the dirty environment. The recommended digestible lysine levels during the pre-starter and starter phases are 1.30 and 1.24% when broilers are reared in the clean environment and 1.26 and 1.165% in the dirty environment, respectively.

Key Words: digestible amino acids, nutritional requirements, performance

Introduction

Genetic improvement programs have selected broilers and pigs for increasing weight gain and feed conversion ratio efficiency. Consequently, the nutritional requirements of these animals have increased. Geraert et al. (2002) demonstrated that lysine requirements of poultry linearly increase as daily weight gain increases. Moreover, lysine is used as the reference amino acid in the formulation of feeds based on the ideal protein concept.

While presenting higher performance efficiency, modern lines of poultry are more sensitive to stressors of pathogenic nature and others, which activate the immune system and lead to lower live performance (McFarlane et al., 1989; Klasing, 1997; Williams et al., 1997).

The objective of the present study was to determine lysine nutritional requirements of male broilers reared in clean or dirty environments during the pre-starter and starter phases.

Material and Methods

The experiments were carried out at the Setor de Avicultura of the Departamento de Zootecnia of Universidade Federal de Viçosa (UFV). Birds were housed in a masonry broiler houses distributed in 1.0 × 2.25-m pens. Wood shavings were used as litter material, and infrared lamps for brooding. Maximum and minimal temperatures were recorded during the entire experimental period as measured by two thermometers placed in different areas of the broiler house. A lighting program of 24 h of natural and artificial light was applied during the entire experimental period.

In the first experiment, lysine nutritional levels for broilers during the pre-starter phase (1-11 days) were determined. A number of 2,000 male Ross chicks, with average initial body weight of 39 g, was distributed in a completely randomized experimental design with a 5 × 2 factorial arrangement of five lysine levels (1.06, 1.12, 1.18, 1.24 or 1.30% digestible lysine) and two types of environment (clean or dirty) with eight replicates of 25 birds each. A level of 2.088 glycine + serine was used in all diets.

Basal diet contained 22.5% crude protein, 2,950 kcal ME/kg and 1.06% digestible lysine. The tested diets were obtained by adding increasing levels of lysine-HCl (0.06%) to the basal diet, maintaining minimum digestible amino acids/digestible lysine ratios of 72% methionine + cystine; 67% threonine; 19% tryptophan and 108% arginine (Table 1).
Average minimum and maximum temperatures recorded were 22.8 ± 0.97 and 34.4 ± 1.85 °C, respectively.

In the second experiment, lysine nutritional levels for broilers during the pre-starter phase (12-22 days) were determined. A number of 1,760 male Ross chicks, with average initial weight of 252 g, was distributed in a completely randomized experimental design with a 5 × 2 factorial arrangement of five lysine levels (1.00; 1.06; 1.12; 1.18 and 1.24% digestible lysine) and two types of environment (clean or dirty) with eight replicates of 22 birds each. A level of 2.002 glycine + serine was used in all diets.

Birds in the second experiment were reared in a different environment from 1 to 11 days of age on new wood-shavings litter and fed on a pre-starter diet formulated according to the recommendations of Rostagno et al. (2005). During the experimental period, from 12 to 22 days, the basal diet contained 21.5% crude protein, 3,000 kcal ME/kg and 1.00% digestible lysine. The test diets were composed of the addition of increasing levels of lysine HCl (0.06%), maintaining minimum digestible amino acids/digestible lysine ratios of 72% methionine + cystine; 67% threonine; 19% tryptophan and 108% arginine (Table 2).

Average minimum and maximum temperatures recorded were 22.4 ± 1.01 and 32.2 ± 1.96 °C, respectively.

In both experiments, the clean environment was washed, disinfected, and a flame gun was used to completely disinfect the environment. New wood shavings were used as litter. On the other hand, the dirty environment was not washed.
or disinfected, and the litter was a wood-shavings type used for two consecutive flocks, obtained from a commercial farm. No antibiotic growth promoters were used in the diets fed to broilers reared in the clean or dirty environments.

At the end of each experiment, the following performance parameters were evaluated: weight gain, feed intake and feed conversion ratio. Data were submitted to statistical analysis using SAEG statistical package according to Ribeiro Júnior (2001).

Results and Discussion

Values of analyzed crude protein and amino acid were different from those calculated due to differences in their content in the raw materials used, particularly in soybean meal, to analytical variation, and to the fact that the nitrogen value of the added synthetic amino acids was not taken into account in the formulation of the experimental diets; however, the minimal ratios between lysine and the other amino acids were achieved (Table 3).

During the pre-starter phase, broilers reared in the clean environment presented higher weight gain as compared with those reared in the dirty environment (P<0.05). However, rearing environment did not influence (P>0.05) feed intake or feed conversion ratio (Table 4). There was a linear effect of lysine on the feed intake (P<0.05) of broilers reared in both environments and a quadratic effect on the weight gain of those reared in the clean (P<0.05) and dirty (P<0.11) environments, respectively. This was also observed by Goulart et al. (2008), but on the other

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Table 2 - Ingredients, chemical composition, and nutritional levels of the experimental diets fed during the starter phase in both evaluated environments (as fed)

<table>
<thead>
<tr>
<th>Digestible lysine level (%)</th>
<th>1.00</th>
<th>1.06</th>
<th>1.12</th>
<th>1.18</th>
<th>1.24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>38.468</td>
<td>38.468</td>
<td>38.468</td>
<td>38.468</td>
<td>38.468</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>31.906</td>
<td>31.906</td>
<td>31.906</td>
<td>31.906</td>
<td>31.906</td>
</tr>
<tr>
<td>Low-tannin sorghum</td>
<td>20.000</td>
<td>20.000</td>
<td>20.000</td>
<td>20.000</td>
<td>20.000</td>
</tr>
<tr>
<td>Corn gluten meal</td>
<td>3.000</td>
<td>3.000</td>
<td>3.000</td>
<td>3.000</td>
<td>3.000</td>
</tr>
<tr>
<td>Oil</td>
<td>2.222</td>
<td>2.222</td>
<td>2.222</td>
<td>2.222</td>
<td>2.222</td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
<td>1.767</td>
<td>1.767</td>
<td>1.767</td>
<td>1.767</td>
<td>1.767</td>
</tr>
<tr>
<td>Limestone</td>
<td>0.984</td>
<td>0.984</td>
<td>0.984</td>
<td>0.984</td>
<td>0.984</td>
</tr>
<tr>
<td>Salt</td>
<td>0.448</td>
<td>0.448</td>
<td>0.448</td>
<td>0.448</td>
<td>0.448</td>
</tr>
<tr>
<td>Starch</td>
<td>0.710</td>
<td>0.591</td>
<td>0.439</td>
<td>0.267</td>
<td>0.041</td>
</tr>
<tr>
<td>DL-methionine 99%</td>
<td>0.114</td>
<td>0.157</td>
<td>0.201</td>
<td>0.245</td>
<td>0.289</td>
</tr>
<tr>
<td>L-lysine HCl 79%</td>
<td>0.066</td>
<td>0.142</td>
<td>0.218</td>
<td>0.294</td>
<td>0.370</td>
</tr>
<tr>
<td>L-threonine 98%</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>0.074</td>
<td>0.114</td>
</tr>
<tr>
<td>L-arginine 99%</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>0.010</td>
<td>0.076</td>
</tr>
<tr>
<td>Choline chloride 60%</td>
<td>0.100</td>
<td>0.100</td>
<td>0.100</td>
<td>0.100</td>
<td>0.100</td>
</tr>
<tr>
<td>Vitamin premix*</td>
<td>0.100</td>
<td>0.100</td>
<td>0.100</td>
<td>0.100</td>
<td>0.100</td>
</tr>
<tr>
<td>Mineral premix*</td>
<td>0.050</td>
<td>0.050</td>
<td>0.050</td>
<td>0.050</td>
<td>0.050</td>
</tr>
<tr>
<td>Anticoccidial2</td>
<td>0.055</td>
<td>0.055</td>
<td>0.055</td>
<td>0.055</td>
<td>0.055</td>
</tr>
<tr>
<td>Butyl-hydroxi-toluene</td>
<td>0.010</td>
<td>0.010</td>
<td>0.010</td>
<td>0.010</td>
<td>0.010</td>
</tr>
</tbody>
</table>

1 Minimal digestible amino acids/digestible lysine ratios: 72% methionine + cystine; 67% threonine; 19% tryptophan and 108% arginine.
2 Salinomycin - 66 mg.
* Vitamin A - 10,000 IU; vit. D₃ - 2,000 IU; vit. E - 30 IU; vit. B₁₂ - 2 mg; vit. B₆ - 3 mg; vit. B₉ - 0.015 mg; pantothenic acid - 12 mg; biotin - 0.10 mg; vit. K₃ - 3 mg; folic acid - 1.0 mg; nicositonic acid - 50 mg; selenium - 0.25 g; manganese - 106 g; iron - 100 g; copper - 20 mg; cobalt - 2 mg; iodine - 2 mg; zinc - 50 mg.
hand, Toledo et al. (2007) verified a linear reduction in the weight gain and feed intake as digestible lysine levels in the pre-starter diet increased.

Dietary lysine levels linearly influenced (P<0.05) feed conversion ratio only of broilers reared in the clean environment (Figure 1), differently from Goulart et al. (2008), who observed a quadratic effect of lysine levels on the feed conversion ratio of pre-starter broilers, and Toledo et al. (2007), who did not find any effect of increasing digestible lysine level on the feed conversion ratio of pre-starter broilers.

Although the birds reared in the clean environment presented higher weight gain, their digestible lysine nutritional requirement for weight gain was lower than that obtained for the birds reared in the dirty environment. However, the feed conversion ratio of the broilers reared in the dirty environment was not influenced by increasing dietary digestible lysine levels.

The digestible lysine nutritional requirement values of 1.197% and 1.260%, calculated for weight gain of broilers reared in the clean and the dirty environments, respectively, are below those recommended by Rostagno et al. (2005), of 1.285% for the period of 1 to 11 days of age.

As well as in the pre-starter phase, the analyzed crude protein and amino acids levels in the starter diet were different from the calculated levels, but the minimum ratio of lysine to the other amino acids was achieved (Table 5).

![Figure 1 - Effect of dietary digestible lysine level on the feed conversion ratio of broilers reared in a clean environment during the pre-starter and starter phases.](image-url)
intake (P<0.05) when compared with those reared in the dirty environment. Feed conversion ratio was not influenced (P>0.05) by the rearing environment.

Digestible lysine levels had a linear influence (P<0.05) in weight gain and feed conversion ratio (Figure 1) of broilers reared in the clean environment, and quadratically affected (P<0.05) these parameters in those reared in the dirty environment. Lana et al. (2005) also observed a linear effect (P<0.05) of digestible lysine levels on weight gain, but did not find any significant effect on feed conversion ratio. On the other hand, feed intake was not affected (P>0.05) by increasing digestible lysine levels, as previously observed by Lana et al. (2005).

The results obtained in the present study with birds reared in the clean environment are contrasting with the findings of Goulart et al. (2008), who observed a linear effect of lysine levels on feed conversion ratio and a quadratic effect on weight gain and feed intake. Campestrini et al. (2010) also found a quadratic effect of lysine on weight gain, but linear effect on feed conversion ratio.

The recommended digestible lysine levels for this phase were 1.24% for broilers reared in the clean environment and 1.158% for those in the dirty environment. The recommended level of 1.24% digestible lysine for broilers reared in the clean environment is higher than those recommended by the NRC (1994), Barboza (2000), Costa et al. (2001), Lana et al. (2005), Rostagno et al. (2005) and Goulart et al. (2008), but below the levels recommended by Campestrini et al. (2010).

Except for the digestible lysine levels recommended by Rostagno & Pack (1995); Han & Baker (1994) and Costa et al. (2001), who found that lysine requirements for feed conversion ratio were always higher than those for weight gain, this was not the case in the present study, except for the lysine requirements of broilers reared in the clean environment during the pre-starter phase.
When performance data of the two evaluated environments were compared, it was observed that broilers reared in the clean environment consistently performed better and had higher digestible lysine requirements than those reared in the dirty environment. Klasing & Barnes (1988) also found worse performance and lower lysine and methionine requirements in broilers whose immune system was stimulated by an environmental challenge.

Roura et al. (1992) found that both acute stimulation by S. typhimurium lipopolysaccharide injection and chronic stimulation by a dirty environment of the immune system caused the release of interleukin-1 (IL-1), resulting in worse broiler performance.

Klasing et al. (1987), Klasing & Johnstone (1991), Klasing (1994) and Johnson (1997) reported that immune system stimulation and the consequent release of cytokines, such as interleukins 1 and 6 (IL-1 and IL-6) and tumor-necrosis factor (TNF-a), reduce feed intake and deviate nutrients from growth to the immune system, leading to lower nutritional requirements. The performance data obtained in the present study are consistent with literature data that showed the chronic stimulation of the immune system of broilers reared in dirty environments reduced broiler performance and nutritional requirements.

Conclusions

Digestible lysine nutritional requirements during the pre-starter and starter phases of broilers reared in clean environments are 1.30 and 1.24%, respectively, and in dirty environments, 1.26 and 1.165%, respectively.

References
