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Lysine Requirement of Male White Pekin Ducklings from Seven to Twenty-one Days of Age

Ming Xie[1, 2], Yuming Guo[1, *], Ting Zhang[2], Shuisheng Hou[2] and Wei Huang[2]

[1] State Key Laboratory of Animal Nutrition, College of Animal Science and Technology, China Agricultural University, Beijing, 100193, China

ABSTRACT : A dose-response experiment with five lysine levels (0.65, 0.80, 0.95, 1.10, and 1.25%) was conducted to evaluate the lysine requirement of male White Pekin ducklings from 7 to 21 days of age. Two hundred and eighty, 7-day-old, male White Pekin ducklings were allocated to 5 experimental treatments, each containing 8 replicate pens with 7 birds per pen. Feed and water were provided *ad libitum* from 7 to 21 days of age. At 21 days of age, weight gain, feed intake, feed/gain, breast meat weight, and breast meat yield relative to body weight of ducklings from each pen were all measured. As dietary lysine level increased, weight gain, feed intake, feed/gain, breast meat weight, and breast meat yield of ducklings were all improved significantly ($p<0.05$). According to broken-line regression analysis, the lysine requirement of male White Pekin ducklings from 7 to 21 days of age for weight gain, feed/gain, breast meat weight, and breast meat yield was 0.84, 0.90, 0.97, and 0.98%, respectively. Considering that Pekin duck production is directed to meat production, the lysine requirement of male starter Pekin ducklings during this period is suggested to be 0.98%. (**Key Words :** Duckling, Lysine, Requirement)

INTRODUCTION

Lysine is the second limiting amino acid in poultry diets and the level of this amino acid is usually considered in diet formulation for ducks, but there is little research on the lysine requirements of early starter Pekin ducklings. The lysine requirement of NRC (1994) for Pekin ducklings from hatch to 14 days of age is 0.9%, but this recommendation is based on very few studies and only one study has been conducted before 21 days of age (Chen and Shen, 1979). Since the publication of the NRC (1994) recommendations, there have been few studies on the lysine requirement of starter Pekin ducklings. Bons et al. (2002) found that the lysine requirement for weight gain and gain/feed of male Pekin ducklings from hatch to 21 days of age was 1.17 and 1.06%, respectively, and Wang et al. (2006) estimated the dietary lysine need of White Pekin ducklings from hatch to 14 days of age to be 1.10% for weight gain. These data indicate that the lysine requirement of the modern starter Pekin ducklings may be higher than the NRC (1994) recommendation. However, to date, growth performance has served as the sole criterion for the determination of duck lysine requirements during the starter period and no consideration has been given to breast meat yield during this period. As the most valuable part of the poultry carcass, breast meat is more sensitive to dietary lysine deficiency than other skeletal meats in chicks (Tesseraud et al., 1996) and it was usually used to evaluate the effects of lysine on carcass characteristics of growing or finishing broilers (Moran and Bilgili, 1990; Acar et al., 1991; Bilgili et al., 1992; Kerr et al., 1999; Corzo et al., 2006; Tang et al., 2007; Dozier et al., 2008). However, a high dietary lysine level could also improve breast meat yield during the starter period, as confirmed by many studies in starter chicks (Tesseraud et al., 1999; Labadan et al., 2001; Urdaneta-Rincon and Leeson, 2004; Bastianelli et al., 2007) which suggested that breast meat yield could serve as another sensitive response criterion for evaluating the lysine requirement of poultry during the starter period. At present, Adams et al. (1983) and Bons et al. (2002) found improvements in breast meat yield of growing Pekin ducks fed diets with increasing lysine levels but no studies are available for starter ducklings. Therefore, the objective of our study was to determine the lysine requirements of modern White Pekin ducklings from 7 to 21 days of age

* Corresponding Author: Yuming Guo. Tel: +86-10-6273-3900, Fax: +86-10-6273-3900, E-mail: guoyum@cau.edu.cn

[2] Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, 100193, China.

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based on growth performance and breast meat yield using graded dietary lysine levels.

MATERIALS AND METHODS

Six hundred, one-day-old, male White Pekin ducklings from one commercial hatchery were raised in wire-floor pens with a common starter diet (Table 1) from hatch to 7 days of age. During this period, water was supplied in plastic troughs and feed was offered in pellet form. All ducklings had free access to water and feed and lighting was continuous.

A lysine-deficient basal diet was used in our study (Table 1). To produce experimental diets, the basal diet was produced firstly and then five experimental diets with different dietary lysine levels (0.65, 0.80, 0.95, 1.10, and 1.25%) were produced by blending the basal diet and different supplemental levels of L-lysine·HCl. All experimental diets were pelleted. The CP of the basal diet was determined by the Kjeldahl procedure according to the method recommended by the Ministry of Agriculture of China (1994). The amino acid contents of basal and experimental diets were analyzed by ion-exchange chromatography with an amino acid analyzer (L-800, Hitachi, Tokyo) after acid hydrolysis according to the method recommended by the Ministry of Agriculture of China (2000). The analyzed lysine concentrations in the five experimental diets were 0.65, 0.83, 0.94, 1.08, and 1.27%, which were similar to the calculated lysine values.

At 7 days of age, all birds were weighed individually and some birds with the lowest or highest body weight were removed. Then, two hundred and eighty birds were selected on the basis of the average body weight of the remaining birds. These birds, with average body weight of 213±30 g, were divided to 5 experimental treatments, each containing 8 replicate pens with 7 birds per pen. Feed and water were provided *ad libitum* from 7 to 21 days of age. During this period, feed was offered in pellet form and water was supplied by nipple drinker lines. At 21 days of age, the weight gain, feed intake, and feed/gain of ducklings from each pen were measured. Feed intake and feed/gain were all corrected for mortality. After being deprived of feed for 12 h, two ducklings were selected from each pen according to the average body weight of the corresponding pen and these birds were killed and eviscerated manually. Then, breast meat including *pectoralis major* and *pectoralis minor* was removed from carcasses manually. Breast meat was skinless and boneless. Breast meat weight and breast meat yield relative to live BW at processing were measured.

Data were analyzed as a completely randomized design by the one-way ANOVA procedure of SAS software (SAS Institute, 2003) and pen was used as the experimental unit for analysis. When dietary treatment was significant ($p<0.05$), means were compared using the Duncan's multiple comparison procedure of SAS software (SAS Institute, 2003). In our study, broken-line regression analysis (Robbins et al., 2006) was used to estimate the lysine requirements of starter ducklings by the NLIN

Table 1. Composition of common starter diet and basal diet during the starter period (% as fed)

Item	Common starter diet (0 to 7 d)	Basal diet (7 to 21 d)
Ingredient		
Corn	62.2	65.7
Soybean meal (44% CP)	34	5.3
Peanut meal (48% CP)	-	25
Dicalcium phosphate	1.5	1.5
Limestone	1.0	1.2
NaCl	0.3	0.3
Premix	1.0[1]	1.0[2]
Analyzed composition		
Metabolizable energy (kcal/kg)	2,814[3]	2,900[3]
Crude protein	20.6	20.3
Lysine	1.09	0.65
Methionine	0.47	0.48
Methionine+cystine	0.82	0.84
Threonine	0.78	0.69
Tryptophan	0.25	0.23
Isoleucine	0.79	0.67
Leucine	1.82	1.55
Valine	0.93	0.79
Arginine	1.53	1.37
Calcium	0.83[4]	0.88[4]
Non-phytate phosphorus	0.41[4]	0.43[4]

[1] Supplied per kilogram of total diet: 1.6 g DL-methionine; Cu ($CuSO_4 \cdot 5H_2O$), 10 mg; Fe ($FeSO_4 \cdot 7H_2O$), 60 mg; Zn (ZnO), 60 mg; Mn ($MnSO_4 \cdot H_2O$), 80 mg; Se ($NaSeO_3$), 0.3 mg; I (KI), 0.2 mg; Cr (Cr_2O_3), 0.15 mg; choline chloride, 1,000 mg; vitamin A (retinyl acetate), 10,000 IU; vitamin D_3 (Cholecalciferol), 3,000 IU; vitamin E (DL-α-tocopheryl acetate), 20 IU; vitamin K_3 (menadione sodium bisulfate), 2 mg; thiamin (thiamin mononitrate), 2 mg; riboflavin, 8 mg; pyridoxine hydrochloride, 4 mg; cobalamin, 0.02 mg; calcium-D-pantothenate, 20 mg; nicotinic acid, 50 mg; folic acid, 1 mg; biotin, 0.2 mg.

[2] Supplied per kilogram of total diet: 2.3 g DL-methionine; 1.2 g L-Threonine; 0.8 g L-Valine; 0.4 g L-Tryptophan; 0.6 g L-Isoleucine; Cu ($CuSO_4 \cdot 5H_2O$), 10 mg; Fe ($FeSO_4 \cdot 7H_2O$), 60 mg; Zn (ZnO), 60 mg; Mn ($MnSO_4 \cdot H_2O$), 80 mg; Se ($NaSeO_3$), 0.3 mg; I (KI), 0.2 mg; Cr (Cr_2O_3), 0.15 mg; choline chloride, 1,000 mg; vitamin A (retinyl acetate), 10,000 IU; vitamin D_3 (Cholecalciferol), 3,000 IU; vitamin E (DL-α-tocopheryl acetate), 20 IU; vitamin K_3 (menadione sodium bisulfate), 2 mg; thiamin (thiamin mononitrate), 2 mg; riboflavin, 8 mg; pyridoxine hydrochloride, 4 mg; cobalamin, 0.02 mg; calcium-D-pantothenate, 20 mg; nicotinic acid, 50 mg; folic acid, 1 mg; biotin, 0.2 mg.

[3] The values were calculated according to the AME of chickens (Ministry of Agriculture of China, 2004).

[4] The numbers are calculated values.

Table 2. Effects of dietary lysine on growth performance and breast meat of male White Pekin ducklings from 7 to 21 days of age[1]

Dietary lysine level (%)	Daily weight gain (g/bird/d)	Daily feed intake (g/bird/d)	Feed/gain (g/g)	Breast meat weight (g)	Breast meat yield (%)
0.65	59.6[c]	132.8[b]	2.23[a]	17.8[b]	1.54[b]
0.80	70.1[b]	145.2[a]	2.07[b]	20.3[b]	1.67[b]
0.95	73.4[a]	143.4[a]	1.95[c]	24.3[a]	1.90[a]
1.10	72.6[ab]	141.9[a]	1.95[c]	24.5[a]	1.91[a]
1.25	72.3[ab]	143.6[a]	1.99[c]	24.5[a]	1.94[a]
Pooled SEM	4.3	8.9	0.06	4.5	0.32

[a-c] Means with different superscripts within the same column differ significantly ($p<0.05$).
[1] Results are means with n = 8 per treatment.

procedure of SAS software (SAS Institute, 2003) according to the following model:

$$y = l+u(r-x)$$

where y = response criteria (weight gain, feed/gain, and breast meat), x = dietary lysine level (%), r = lysine requirement, l = the response at x = r, u = the steepness of the curve. In this model, y = l when x>r.

RESULTS AND DISCUSSION

In the present study, although the energy and protein levels of experimental diets were different from the NRC (1994) recommendation, they were adequate for duck growth. This was supported by Ali and Sarker (1992) who found that the protein and energy requirement of Muscovy ducklings during the starter period were 20% and 2,900 kcal ME/kg, respectively. In addition, peanut meal was used to formulate the lysine-deficient basal diet in our study, due to its lower lysine content than soybean meal, and this feedstuff was also used in the study of Chen and Shen (1979) in which the lysine requirement of mule ducklings was evaluated successfully. In broilers, if the crystalline amino acids are supplemented to diets properly, the use of peanut meal as a major feed ingredient can also be adequate to support the growth of birds when compared with other common types of diets (Kidd et al., 1999). More recently, a basal diet containing a large proportion of peanut meal was used successfully to determine the valine need of broilers (Corzo et al., 2008). Therefore, the use of peanut meal in our experimental diets should not affect the accuracy of our results.

The weight gain, feed intake, feed/gain, and breast meat weight or yield of male starter Pekin ducklings were all improved significantly by increasing dietary lysine level (Table 2), which confirmed that the basal diet was lysine-deficient and the experimental period was adequate to assess the duck response to increasing dietary lysine level. Our results were supported by Chen and Shen (1979) who successfully estimated the lysine requirement of mule ducklings from 9 to 21 days of age by a dose-response growth study. Furthermore, Garcia and Batal (2005) found that a minimal change occurred in the digestible lysine requirement of broilers within the first 21 days of age and digestible lysine requirement determined with birds from 7 to 21 days of age appeared to be adequate for birds from hatch to 7 days of age, which also supports the validity of the 14-day experimental period in our study.

In the present study, the weight gain and feed/gain of ducklings were all improved significantly as dietary lysine level increased ($p<0.05$) and these two response criteria reached a plateau when dietary lysine level was above 0.95% (Table 2). Therefore, broken-line regression analysis was used to estimate the lysine requirements of the starter ducklings for growth rate. According to this regression analysis, the lysine requirements of Pekin ducklings from 7 to 21 days of age were 0.84 and 0.90% for weight gain and feed/gain, respectively (Table 3), and these estimated values were identical with the observed growth response data which showed that dietary lysine level was optimized between 0.80 and 0.95% for weight gain or feed/gain (Table 2). Considering that lysine requirement increased as dietary CP level increased and this amino acid requirement may be

Table 3. Lysine requirements of male White Pekin ducklings from 7 to 21 days of age based on broken-line regression analysis

Response criterion	Requirement[1] (%)	95% confidence interval (%)	Probability	R^2
Weight gain (g/bird/d)	0.84±0.01	0.79-0.89	0.0050	0.995
Feed/gain (g/g)	0.90±0.04	0.72-1.08	0.0192	0.981
Breast meat weight (g)	0.97±0.02	0.87-1.08	0.0099	0.990
Breast meat yield (%)	0.98±0.34	0.84-1.13	0.0168	0.983

[1] Expressed as requirement±SE.

a constant proportion to dietary CP level (Sterling et al., 2003), the percentage of lysine to dietary CP was used to compare differences between our results and others. Based on these percentages, the lysine requirements estimated by us (4.14% for weight gain and 4.43% for feed/gain) were lower than the values estimated by Bons et al. (2002) (5.22% for weight gain and 4.73% for gain/feed) and Wang et al. (2006) (5.42% for weight gain), but they were higher than the NRC (1994) recommendation of Pekin ducks from hatch to 2 weeks of age (4.09%). Our study and the aforementioned studies all showed that the lysine requirement should be reviewed to adapt to the modern duck genotype.

Our study was the first to examine the effects of dietary lysine on breast meat of starter Pekin ducklings. The improvement of breast meat by increasing dietary lysine level also took place during the starter period and it was confirmed that breast meat weight and yield of ducklings were both increased significantly ($p<0.05$) when dietary lysine level was above 0.80% (Table 2); similar results were also reported in starter broilers (Tesseraud et al., 1999; Labadan et al., 2001; Urdaneta-Rincon and Leeson, 2004; Bastianelli et al., 2007). In our study, considering the diminishing-return response of breast meat when dietary lysine level was above 0.95%, broken-line regression analysis was used to estimate the lysine requirement for breast meat. According to this regression analysis, the lysine requirement for breast meat weight and yield of Pekin ducklings was 0.97 and 0.98%, respectively (Table 3). Compared with the lysine requirement of Pekin ducklings for growth performance estimated by us, the lysine requirement of the starter Pekin ducklings was higher for breast meat than for weight gain and feed/gain (Table 3), and our results are in agreement with those in growing Pekin ducks reported by Bons et al. (2002). Furthermore, our results are also supported by Labadan et al. (2001) who observed a similar phenomenon in starter broilers from hatch to 2 weeks of age. In broilers, birds fed lysine-deficient starter diets had poorer breast meat yield at market age than those fed lysine-adequate starter diets, although the lysine-adequate diets were fed to all birds during the subsequent growing period (Kidd et al., 1998; Kidd and Fancher, 2001). Therefore, the increasing lysine requirement of starter Pekin ducklings should be considered further if the breast meat yield of birds is to be maximized at market age.

In conclusion, the lysine requirement of male Pekin ducklings from 7 to 21 days of age was 0.84, 0.90, 0.97, and 0.98% for weight gain, feed/gain, breast meat weight, and breast meat yield, respectively. Considering that Pekin duck production is directed to meat production, the lysine requirement of male starter Pekin ducklings during this period is suggested to be 0.98%.

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