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Short communication

Effects of dietary protein on threonine requirements of Pekin ducks from hatch to 21 days of age

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ABSTRACT

A 2 × 6 factorial experiment with two dietary crude protein (CP) levels (17.73% with 0.46% Thr and 20.89% with 0.54% Thr) and six supplemental threonine (Thr) levels (0, 0.06, 0.12, 0.18, 0.24, and 0.30%) was conducted to study the effects of dietary CP on the levels of Thr required for the optimal growth of white Pekin ducks from hatch to 21 d of age. A total of 576 one-d-old male white Pekin ducks were assigned to one of 12 experimental treatment groups. Each treatment group consisted of six replicate pens with eight ducks per pen. All ducks were reared in raised wire-floor pens from hatch to 21 d of age. Birds that were fed basal diets not supplemented with crystalline Thr had the worst weight gain and feed intake at both dietary CP levels. Quadratic broken-line regression analysis was used to estimate the Thr requirement of ducks. When expressed as a percentage of diet, the estimated Thr requirement was 0.610% at 20.89% CP and 0.556% at 17.73% CP. When expressed as a percentage of dietary CP, the Thr requirement was 2.931% at 20.89% CP and 3.146% at 17.73% CP. When expressed as a percentage of dietary lysine, the estimated Thr requirement was 53.0% at 20.89% CP and 52.0% at 17.73% CP. The difference between the Thr requirement at 17.73 and 20.89% CP was examined by *t*-test. This analysis demonstrated that dietary CP influenced the Thr requirement when it was expressed as a percentage of diet or as a percentage of dietary CP ($P < 0.05$). In contrast, Thr requirement was not affected by dietary CP when it was expressed as a percentage of dietary lysine ($P > 0.05$). It was concluded that dietary CP can cause variations in the Thr requirement of Pekin ducks, but expressing the Thr requirement as a percentage of dietary Lys can reduce this variation.

1. Introduction

Because threonine (Thr) is the third-limiting amino acid after methionine and lysine in poultry diets and is critical for maintaining intestinal structure and promoting intestinal mucin secretion in poultry (Horn et al., 2009, 2010; Xie et al., 2014; Zhang et al., 2014), increasing dietary Thr could improve the growth performance of starter and growing Pekin ducks. Although the threonine requirements of poultry were not outlined by the NRC (1994), Xie et al. (2014) and Zhang et al. (2014)

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Table 1
Composition of basal diets (% as-fed basis).

Ingredient (%)	20% CP	17% CP
Corn	22.00	25.25
Wheat	48.00	53.00
Peanut meal	24.50	16.00
Soybean oil	1.00	0.971
Dicalcium phosphate	1.30	1.30
Limestone	1.00	1.00
Salt	0.30	0.30
DL-methionine	0.20	0.35
L-lysine·HCL	0.70	0.80
L-tryptophan	–	0.029
Premix [a]	1.00	1.00
Total	100.00	100.00
Calculated composition		
Metabolizable energy (MJ/kg)[b]	12.10	12.20
Calcium (%)	0.80	0.79
Nonphytate P (%)	0.38	0.37
Analysed composition		
Crude protein (%)	20.89	17.73
Lysine (%)	1.15	1.07
Methionine (%)	0.48	0.52
Methionine + cysteine (%)	0.80	0.83
Threonine (%)	0.54	0.46
Tryptophan (%)	0.22	0.23

[a] Supplied per kilogram of total diet: Cu ($CuSO_4 \cdot 5H_2O$), 8 mg; Fe ($FeSO_4 \cdot 7H_2O$), 60 mg; Zn (ZnO), 60 mg; Mn ($MnSO_4 \cdot H_2O$), 100 mg; Se ($NaSeO_3$), 0.3 mg; I (KI), 0.4 mg; choline chloride, 1000 mg; vitamin A (retinyl acetate), 4000 IU; vitamin D_3 (cholcalciferol), 2000 IU; vitamin E (DL-α-tocopheryl acetate), 20 IU; vitamin K_3 (menadione sodium bisulfate), 2 mg; thiamin (thiamin mononitrate), 2 mg; riboflavin, 10 mg; pyridoxine hydrochloride, 4 mg; cobalamin, 0.02 mg; calcium-D-pantothenate, 20 mg; nicotinic acid, 50 mg; folic acid, 1 mg; and biotin, 0.15 mg.
[b] This value is calculated according to the AME of chickens (Ministry of Agriculture of China, 2004).

reported Thr requirements for starter and growing modern Pekin ducks of 0.67% and 0.62–0.73%, respectively. In broilers, a restricted maximum likelihood statistical analysis of published data showed that dietary protein concentration in trial diets explained most of the variation in Thr requirements. This study also indicated that expressing Thr requirements as a function of dietary protein did not remove the variation contributed by differences in dietary protein (Barkley and Wallis, 2001). In ducks, however, the effects of dietary protein on Thr requirements are not clear. Recently, Sterling et al. (2003) statistically analysed, by *t*-test, published differences in the lysine requirements of broilers fed high and low protein diets. They found that the lysine requirements of broilers are a constant proportion of dietary protein levels. These results provided a way for us to compare nutrient requirements at two different dietary protein levels. Therefore, the objectives of current study were to evaluate the effect of graded concentrations of Thr on the performance of White Pekin ducks fed two different CP levels and to examine whether Thr requirements are a constant proportion of dietary protein or lysine.

2. Materials and methods

2.1. Experimental design and duck husbandry

The animal care and use committee of the Institute of Animal Sciences, Chinese Academy of Agricultural Sciences approved all methods. A 2 × 6 factorial experimental design with two dietary crude protein (CP) levels (17 and 20%) and six supplemental Thr levels (0, 0.06, 0.12, 0.18, 0.24, and 0.30%) was utilized in our study. A total of 576 one-d-old male white Pekin ducks with an average body weight of 55 ± 5 g were assigned to one of 12 different experimental treatments. Each treatment group consisted of 6 replicate pens with 8 ducks per pen. Ducks were reared in raised wire-floor pens (200 × 100 × 40 cm) from hatch to 21 d of age. During this period, ducks had free access to water and feed. Drip-nipple water supply lines provided water, and feed was supplied in pellet form. In the bird house, lighting was continuous; temperature was kept at 33 °C from 1 to 3 d of age, and then reduced gradually to room temperature until 21 d of age.

2.2. Diet and chemical analysis

Two Thr-deficient basal diets with different CP levels (17 and 20%) were formulated (Table 1). These two basal diets were supplemented with crystalline L-Thr (0, 0.06, 0.12, 0.18, 0.24, and 0.30%) at the expense of corn. The CP levels of the basal diets were analysed by the Kjeldahl method, as recommended by the Standardization Administration of China (1994). The amino acid content (excluding tryptophan) of the basal diets, and total Thr levels of all experimental diets, were analysed by ion-exchange chromatography using an amino acid analyzer (L-800, Hitachi, Tokyo) after feed samples were hydrolyzed with 6MHCl for 24 h at 110 °C.The total tryptophan content in basal diets was analysed by reverse-phase high performance