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The optimal lysine and threonine intake for Cobb broiler breeder hens using Reading model

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ABSTRACT

This study aimed to determine the optimal intake of lysine and threonine for broiler breeder hens. Two experiments were conducted to evaluate the responses of birds to digestible lysine (**Lys**) and threonine (**Thr**). Eight treatments were assessed in both experiments, with six replicates of eight birds in the Lys experiment and ten birds in the Thr experiment. The dietary levels of Lys and Thr were obtained by a dilution technique. The experimental period was ten weeks for each amino acid studied, which included six weeks of adaptation and four weeks of data collection. The amino acid intake, egg mass and body weight were adjusted using a Reading model. Based on the model coefficients, the cost of the synthetic amino acids sources and the price of fertile eggs determined the intake of each amino acid to maximize. The minimum intake of Lys and Thr reduced egg production by 40 and 30%, respectively, the weight of the eggs decreased by 12 and 9% with the same intake of Lys and Thr, respectively. The models generated by predicting Lys and Thr intake were as follows: $Lys = 11 \times E + 31 \times W$ and $Thr = 9.5 \times E + 32 \times W$, where E = egg mass, g/bird per day, and W = body weight, kg/bird. Based on the models, 3 kg birds with an egg mass production of 50 g/day require 643 mg/bird per day of Lys and 569 mg/bird per day of Thr. The optimum economic intake was calculated at 954 and 834 mg/bird per day for Lys and Thr, respectively, reflecting a dietary concentration of 0.636% Lys and 0.556% Thr for a feed intake of 150 g/bird per day.

1. Introduction

The genetic selection of broiler breeder hens does not produce the same production rates of commercial laying hens. Broiler breeder hens have a considerable amount of lipid in the body (Bowmaker and Gous, 1991) and a restricted feeding system. Commercial laying hens are more efficient in their use of amino acids for egg production (McDonald and Morris, 1985) compared to broiler breeder hens (Bowmaker and Gous, 1991). Despite these differences, published studies on response of broiler breeder hens to the amino acid intake remain limited. The acquisition and maintenance costs of these breeding birds, in addition to sanitary restrictions have limited studies, including those investigating amino acid intake.

A large proportion of Thr and Lys requirement in broiler breeder hens is directed to maintenance needs (Martinez-Amezcua et al., 1999). However, these amino acids are important for egg production since its concentration linearly increase in the egg yolk as their dietary level increases; consequently, yolk weight and egg weight also increase

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(Larbier, 1973). Moreover, the amino acids Lys and Thr are considered the limiting amino acids in the diets for poultry (Harms, 1992). Studies with laying hens submitted to the intake of Lys are found in the literature (Fisher, 1994; Bendezu et al., 2013), but the same does not happen with broiler breeder hens, especially for the amino acid threonine. Some studies have estimated the Lys and Thr requirements. However, most of the publications have demonstrated an applicability that is restricted to the conditions under which those specific studies were performed. Furthermore, the recommendations of Lys of 1216 mg/day (Bornstein et al., 1979) vs 916 mg/day (Ekmay et al., 2013) and Thr of 1152 mg/day (Bornstein et al., 1979) vs 613 mg/day (Ekmay et al., 2013) found in the literature for broiler breeders in the production phase, besides to being scarce, show considerable variation (Gomes et al., 2011).

The optimum intake of amino acids will differ between strains because of genetic selection being applied differentially to rate of egg production, egg size and body weight (Bendezu et al., 2013). For this reason, responses to amino acids may need periodic updating, but it is more important to determine the optimum economic intake of the limiting amino acids on a regular basis, taking into account not only the potential laying performance of the flock but also the relationship between the marginal cost of the amino acids and the marginal revenue for eggs (Bendezu et al., 2013).

A model to determine the optimal intake of the amino acid has been proposed by researchers of the University of Reading (Curnow, 1973; Fisher et al., 1973; Pilbrow and Morris, 1974), which consists of fractioning the requirements for egg production and the maintenance of body weight and also of considering the variation of the requirements of an economic index. Thus, this model allows to derive nutritional recommendations according to the production level, population variability and optimal economic response for additional amino acid supplementation. Considering the genetic improvement of the actual commercial strains, this study was conducted to re-evaluate the responses of broiler breeder hens and to estimate the economically optimal intake of Lys and Thr.

2. Material and methods

2.1. Birds, management and experimental design

The experiments were conducted at the Laboratory of Poultry Science of the São Paulo State University "Júlio de Mesquita Filho" campus of Jaboticabal. This study was approved by the Ethics Committee on Animal Use (CEUA) of the Faculty of Agriculture and Veterinary Sciences, UNESP, Jaboticabal (protocol number 007125-08).

Two experiments were conducted to measure the response of the birds to digestible Lys and Thr. The birds were housed in pens (3.90 × 3.35 m) with a tubular feeder arranged with six nests for laying and a row with six nipple drinkers. The lighting program adopted during the experiment was 16 h of light with 8 h of darkness (16L:8D). The environment was controlled by negative-pressure system with automatic control of temperature, which kept the temperature at 21 °C during the experiment.

The experimental period for both experiments was 70 days. In the Lys experiment, 384 broiler breeder hens (Cobb strain) were used after a molting period at 86 weeks of age. In the Thr experiment, 480 broiler breeder hens (Cobb strain) of 60 weeks of age were used. The experimental design was a completely randomized design with eight treatments and six replicates. Eight birds per replicate were used for the Lys experiment, and 10 birds per replicate were used for Thr experiment. Experimental units were established according to the average egg production and body weight of the birds.

2.2. Treatments and diets

The treatments consisted of eight levels of Lys (**L1-8**) ranging from 2.492 to 8.304 g/kg of Lys and eight levels of Thr (**T1-8**) ranging from 2.036 to 6.788 g/kg of Thr in the diets. These levels of Lys and Thr in the experimental diets were obtained using the dilution technique described by Fisher and Morris (1970). Initially, two summit diets were formulated based on corn and soybean meal, one diet containing 8.30 g/kg of Lys (**L7**) for Lys experiment and other diet with 6.79 g/kg of Thr (**T7**) for Thr experiment, as presented in Table 1. The Lys and Thr levels in these diets were formulated to provide 1.2 times the requirement of the amino acid test (Lys or Thr), based on the recommendations of Rostagno et al. (2005). The requirements of other amino acids were established to provide 1.4 times the requirement, thus, ensuring that the diets were limiting only in Lys or Thr in the experiments. Subsequently, one protein-free diet was formulated for Lys (**L0**) and other protein-free diet for Thr (**T0**) experiment to meet the nutritional requirements for energy, minerals and vitamins, but not for protein and amino acids.

The L7 and T7 diets were diluted with the corresponding protein-free diets (L0 and T0) in the following proportions (%): 30:70 (L1 and T1), 40:60 (L2 and T2), 50:50 (L3 and T3), 60:40 (L4 and T4), 70:30 (L5 and T5), 90:10 (L6 and T6) and 100:0 (L7 and T7). The seven treatments with increasing levels of Lys and Thr in the diets, obtained by dilution technique, are presented in Table 2. The eighth diet in each experiment (**L8** and **T8**) was used to confirm whether the responses of the birds were a function of the limiting amino acid (Lys or Thr) in the diet. These levels were obtained by adding a small quantity of synthetic amino acid to the diet with the lowest level of Lys (**L1** = 2.492 g Lys/kg) or Thr (**T1** = 2.036 g Thr/kg), resulting in L8 = 0.897 g of L-lysine HCl (78%)/kg of L1 and T8 = 0.61 g of L-threonine (98%)/kg of T1 (Table 2).

The ingredients corn, soybean and wheat meal were analyzed for their amino acid content and digestibility using cecectomized cockerels to correct the formulations.

2.3. Data collection

The daily feed supply was 150 g/bird, and the leftovers were quantified weekly to determine the feed intake. Body weight was recorded at the beginning of the experiment, after three weeks, after six weeks and at the end of the experiment (after 10 weeks). Egg production was recorded daily. The egg weights were recorded over three consecutive

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