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Lysine requirements of laying hens

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ABSTRACT

This experiment aimed to model the responses of laying hens to lysine intake (Lys) using three mathematical models. The design used was completely randomized, with eight treatments, six repetitions with eight hens per experimental unit, and three periods of 28 days for each period, using 384 Dekalb White hens. Statistical analyses were performed for treatments, repetitions and period using the procedure of repeated measures in time. The responses for EM and FCR for the different intakes of Lys were adjusted using the models broken line (BL), quadratic polynomial (QP) and reading model (RM). There was an effect of Lys levels and period and an interaction between the levels of Lys and period. The models were adjusted for each experimental period. The biological optimal level of Lys intake was obtained using a combination of the models BL and QP, which was close to the estimate of RM of 707, 660 and 669 mg/bird per day, which allows to meet the requirement of approximately 97% population in the periods of 37–40, 41–44 and 45–48 weeks old. For the cost of L-Lysine HCl and for egg price variation, the economic optimum intake was estimated at 699, 658 and 667 mg of Lys/bird per day for the referred periods.

1. Introduction

Lysine is considered the reference amino acid in diet formulations using the ideal protein concept, and it is associated with protein synthesis in egg mass. When prioritized for protein synthesis, the correct use of Lys and other amino acids in poultry diets improves the efficiency of Lys utilization. Increasing nutrient efficiency by reducing nutrient excretion may help to reduce costs and improve production efficiency while complying with government policies (Bailleul et al., 2000)). Therefore, the availability of dietary nutrients and a precise definition of nutrient requirements are key factors in improving nutrient efficiency. However, studies on laying hens' lysine requirements vary considerably; therefore, it is difficult to choose the optimal value to improve the efficiency under different conditions.

The NRC (1994) recommends 690 mg lysine/bird per day for white egg layers. Higher requirements were reported by Uzu and Larbier (1985): 800 mg/bird per day and Al Bustany and Elwinger (1987): 820 mg/bird per day. This variation can be assigned to genetic and environmental differences. Additionally, most of studies estimated a single value to be used throughout the laying cycle. This does not take into account the changes in egg production over a long period.

These aspects have originated from the empirical method, which is the most common method used to estimate optimal levels of dietary nutrients. In this method, nutritional requirements are defined as the minimal amount of nutrients

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needed to maximize or minimize population performance responses (e.g., egg production). The requirements estimated by this method represent the animal's response to the specific conditions under which the trial was conducted.

A more flexible method is the factorial method, which allows approximation of daily requirements based on combined estimated requirements for maintenance and production. Although this method allows estimation of the requirements for different conditions, the estimates represent only the average individual and the population. The Reading Model proposed by Fisher et al. (1973), which is based on the factorial method, considers the population response through simulation. Additionally, in this simulation, the variables used (BW and EM) are easily obtained under commercial conditions to adjust the factorial equation. Thus, this method allows estimation of the optimal value to improve biological and economic responses using a flexible approach. This experiment aimed to model the responses of laying hens to Lys intake using three mathematical models, to determine the biological and economic optimum levels of Lys intake for laying hens.

2. Materials and methods

This study was approved (Protocol no: 007125-08) and conducted in accordance with the guidelines of the Animal Ethics Committee of the Animal Science and Veterinary Faculty of São Paulo State University (Brazil).

2.1. Birds, housing and design

Three hundred eighty four Dekalb White laying hens, 32- to 48-weeks-old, were used in the experiment. At 32 weeks, hens were individually weighed and placed into cages of eight birds. Each cage was provided with an open trough feeder and two nipple drinkers. Birds were distributed into a completely randomized design with eight treatments and six replicates of eight birds each. The treatments consisted of seven increasing lysine levels (2.73, 3.64, 4.55, 5.46, 6.37, 8.19 and 9.09 g/kg) in the experimental diets and one additional control diet (counter-proof treatment) to confirm if the amino acid was limiting in the diets. The data were collected in three periods of four weeks each (37–40, 41–44 and 45–48 weeks old); the first period (32–36) was considered an adaptation period. Feed in mash form and water (via nipple drinkers) were available ad libitum. The light program was constant and consisted of 16 h of light per day. The temperature and relative humidity, minimum and maximum were 12.81 °C, 35.34% and 32.60 °C, 90.93%, respectively.

2.2. Experimental diets

A concentrate (summit) diet was formulated to provide 1.2 times the amount of Lys recommended of 7.58 g/kg (9.09 g of lysine/kg of diet) by Rostagno et al. (2005), and other amino acids were provided 1.4 times the amount required creating a relative deficiency of Lys. The diets were mixed by diluting the concentrate (summit) with a protein-free diet, according to Fisher and Morris (1970). The two diets were analyzed for protein and amino acid content (Table 1). Mixing proportions of summit and nitrogen free diets and calculated concentration of the limiting amino acid (Table 2). An additional diet was prepared using the first diet (2.73 g of lysine/kg of diet) and supplementing it with 0.91 g of L-Lysine HCl/kg of diet (0.071 g of lysine/kg of diet) providing the digestible lysine content of 2.80 g of lysine/kg of diet. This additional diet (diet 8) is prepared only to confirm whether the tested amino acid was the most limiting in the diets and is not used in the statistical analysis.

Table 1
Composition and nutritional contents of the Summit and N-Free diets (g/kg), as-is basis.

Ingredients	Summit diet	N-Free diet
Corn (8%)	477.7	–
Soybean meal (45%)	285.4	–
Limestone	93.1	87.3
Corn gluten meal (60%)	88.4	–
Soybean oil	30.1	100.0
Dicalcium phosphate	14.7	19.8
Salt	5.3	5.1
DL-Methionine (99%)	2.9	–
Vitamin supplement[a]	1.0	1.0
Choline chloride	0.5	0.5
Mineral supplement[b]	0.5	0.5
L-Tryptophan (98%)	0.3	–
Antioxidant	0.1	0.1
Potassium chloride (99%)	–	12.7
Rice husk	–	205.0
Inert (washed sand)	–	50.0
Corn starch	–	368.0
Sugar	–	150.0
Total	1000.0	1000.0
Nutrient (calculated composition)		
Apparent metabolizable energy	11.9	11.9
Calcium	40.2	40.2
Sodium	2.3	2.3
Available phosphorus	3.8	3.8
Potassium	6.4	4.7
Crude fiber	24.0	45.0
Nutrient (analyzed composition)		
Crude protein	224.4	2.1
Digestible methionine	6.5	–
Digestible Met+Cys	9.6	–
Digestible lysine	9.1	–
Digestible threonine	7.5	–
Digestible arginine	12.2	–
Digestible isoleucine	8.8	–
Digestible leucine	23.6	–
Digestible valine	9.6	–
Digestible tryptophan	2.2	–

[a] This premix supplied the following per kilogram of diet: Vit A 7500 IU; Vit D_3 2000 IU; Vit E 10 IU; Vit K_3 1.8 mg; Vit B_1 1.5 mg; Vit B_2 4 mg; Vit B_3 25 mg; Vit B_5 10 mg; Vit B_6 1.7 mg; Vit B_{12} 0.013 mg; Folic Acid 0.5 mg; Biotin 0.05 mg; Selenium 0.33 mg.

[b] This premix supplied the following per kilogram of diet: Cu 11 mg; Fe 55 mg; I 1.1 mg, Mn 77 mg; Zn 72 mg.

2.3. Data collection

Egg collection was performed daily; egg weight was obtained in the last two days of each experimental period. Two replicates per treatment were randomly selected to obtain the mean body weight (BW) and the standard deviation of the body weight (σBW). The birds were