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The response of broilers during three periods of growth to dietary valine

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ABSTRACT

In diets based on corn and soybean meal valine is considered the fourth limiting amino acid. Despite that, there have been few studies to date on the response of broilers to dietary valine and most of them use empirical procedures leading to a great variation in the recommendations. Thus, the aim of this study was to quantify the performance and body composition of broiler chickens subjected to different intakes of digestible valine using the dilution technique. Three trials were conducted separately with Cobb 500 broilers in the starter (1–14 days), grower (14–28 days) and finisher phase (28–42 days). In the starter and grower phases, the birds were distributed in a completely randomized design with eight treatments (seven levels of valine and a control treatment), with seven replicates, each consisting of 12 birds for starter and grower phases while 10 birds were used in the finisher phase. Basal diets were formulated by dilution technique, being one summit diet with valine as the first limiting amino acid and diluted with a nitrogen-free diet to obtain the intermediary levels. Valine intake for maximum weight gain, valine deposition, and protein deposition in the defeathered body and feather were estimated with broken-line models. Body fat content was calculated with linear regressions. Results indicate that to maximize performance of broiler chickens across several parameters, the recommended requirement of digestible valine for the starter, grower and finisher diet is 226, 637 and 1231 mg/bird/day, respectively. These recommendations allow achieving optimum performance in the broiler production system but they can be different depending on way birds are sold (whole chicken or cut-up) and age of the birds at slaughter.

1. Introduction

Several essential amino acids are currently available as dietary supplements in the poultry industry, particularly those that are most limiting in the feed. The availability of synthetic amino acids enables the amino acid requirements for growing birds

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to be more precisely met, as a result, has improvements in the poultry nutrition. Specifically, it has enabled the formulation of feeds based on digestible amino acids. Moreover, the use of the concept of ideal protein for diet formulation (Baker and Han, 1994) allowed the reduction of the amount of protein in the diet, hence cost, therefore reducing the excretion of nitrogen to the environment.

In order to further reduce the levels of crude protein in broiler feeds a more precise estimation of the response to the main limiting essential amino acids is needed. These levels may be estimated using a factorial approach, accounting for the amount required for maintenance and protein deposition of body throughout the growing period, using as tool, for example the EFG Software (2014) or by conducting response trials in which each amino acid of interest is made to be first-limiting in the series of feeds applied (Gous, 1980; Gous and Morris, 1985). Responses to the main limiting amino acids, that being methionine, lysine and threonine which are routinely supplemented in the diets of broiler chickens are now well established. As the amino acid composition of the protein differs between feed ingredients, the next-limiting amino acid that being valine, isoleucine, tryptophan or arginine, will depend on the specific composition of the broiler feed (Corrent and Bartelt, 2011).

In diets based on corn and soybean meal, valine is the fourth limiting amino acid (Kidd and Hackenhaar, 2006; Corzo et al., 2009). Thornton et al. (2006) suggested that valine is the next limiting amino acid after threonine in diets in which ingredients of animal origin are excluded, especially in the grower and finisher periods, when a higher proportion of grains is used (Corzo et al., 2004).

However, there have been few studies to date on the response of broilers to dietary valine. Suggested inclusion rates in broiler feeds range from 7.4 to 9.0 g/kg diet (Farran and Thomas, 1990; Bae et al., 1999; Mack et al., 1999; Baker et al., 2002; Corzo et al., 2004,2009; Tavernari et al., 2013) but these estimates can show considerable variation depending on the mathematical procedures used to estimate them and the response parameters measured. Moreover, previous studies used supplementation techniques to determine valine requirements. This technique has been criticized because of the successive increase of the limiting amino acid in the basal diet induces an unbalance of other amino acids. An alternative to this technique is the dilution technique proposed by Fisher and Morris (1970) which consists of sequentially diluting a high protein diet with an iso-energetic diet free of protein to obtain intermediate levels of the amino acid evaluated, which ensures that the ratio between the amino acids remains constant (Gous, 1980).

Therefore, the aim of this study was to quantify the performance and body composition of broiler chickens subjected to different intakes of digestible valine using the dilution technique.

2. Material and methods

The experiment was conducted at the Faculty of Veterinary Medicine and Animal Science, University of São Paulo, Campus Pirassununga. This experiment was authorized by the Ethics Committee on animal use of the University of São Paulo (protocol n° 2153/2011).

2.1. Birds, experimental design and diets

Three experiments were conducted to measure the response of broilers to digestible valine in the starter (1–14 days), grower (14–28 days) and finisher (28–42 days) phases. The birds were weighed individually at day old, at 14 and 28 d in order to standardize body weight of the experimental units. The seven levels of dietary digestible valine and the control diet were distributed in a completely randomized design, using seven replicates of 12 birds for starter and grower phases while 10 birds were used in the finisher phase. In the experiments, male broilers of the Cobb 500 strain were used, with initial body weights of 49.2 ± 0.11 g at 1 day, 278 ± 0.87 g at 14 days and 1099 ± 3.56 g at 28 day of age.

The birds which were used to grower and finisher phase of the experiment were raised separately up to the 14th (grower phase) and 28th day of age (finisher phase), respectively, using feed formulated to meet the nutritional recommendations from Brazilian Table for Poultry and Swine (Rostagno et al., 2005). From 1 to 14 days of age the birds were housed in metabolic cages (1.0 m × 0.4 m) arranged in three batteries of six floors, equipped with electric heating, feeders and nipple drinkers. For the other phases the birds were housed in an experimental facility containing 100 pens of 1.5 m^2 each, lined with wood shavings (5 cm thick), equipped with a tubular feeder and nipple drinkers. During the experiment, lighting was provided 24 h daily. Water and feed were provided *ad libitum*. The maximum and minimum temperatures and relative humidity (RH) were recorded daily, inside the facility. From 1 to 14 days, the temperature varied from 31.5 ± 0.49 to 26.3 ± 0.36 °C and RH from 78 ± 6.6 to 61 ± 2.6%, respectively. In the grower phase (14–28 days) the temperatures ranged from 28.2 ± 0.64 to 21.3 ± 0.14 °C and RH from 91 ± 2.5 to 70 ± 3.5%. In the finisher phase, the ranges were from 30.7 ± 0.48 to 21.0 ± 0.16 °C and from 91 ± 1.8 to 58 ± 1.7%, respectively.

Total amino acids content of the ingredients used in the formulation were analysed using high performance liquid chromatography (HPLC) by Ajinomoto Ltd. For that, samples were hydrolysed for 23 h at 110 °C, after performic acid oxidation. Methionine was transformed into methionine sulfone and the cysteine into cysteic acid. These values were converted to a digestible basis using the digestibility coefficients from Brazilian Tables for Poultry and Swine (Rostagno et al., 2005).

Two diets were formulated, one with a high protein content (D1) and the other protein-free (D7). The summit diet was formulated to contain 1.20 times the requirement for valine recommended in the Brazilian Tables for Poultry and Swine (Rostagno et al., 2005) and the other amino acids were formulated to contain a minimum of 1.4 times the recommendations. This procedure is used to provide a high concentrate protein diet with the valine as the first limiting amino acid at a relative