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Short communication

Effects of riboflavin supplementation on growth performance, carcass traits, and riboflavin status of growing male white Pekin ducks

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ABSTRACT

An experiment involving six dietary riboflavin concentration (1.38, 2.38, 3.38, 4.38, 5.38, and 6.38 mg/kg) was conducted to determine the effects of riboflavin on performance and riboflavin status of growing male white Pekin ducks in terms of growth performance, carcass traits, and free riboflavin, flavin mononucleotide (FMN) and flavin adenine dinucleotide (FAD) concentration in the liver and plasma. A basal corn-soybean meal containing 1.38 mg/kg of naturally occurring riboflavin was used and this basal diet was fed with 0, 1, 2, 3, 4, and 5 mg/kg diet of supplemental riboflavin. One-day-old male white Pekin ducks were fed common starter diets from hatch to 14 days of age and then fed the experimental diets from 15 to 35 days of age. A total of 288 15-day-old ducks were allotted to 6 dietary treatments with 6 replicate pens of 8 birds per pen. At 35 days of age, the average daily weight gain (ADG), average daily feed intake (ADFI), gain to feed ratio (G:F), and percentage yield of breast and leg meat, abdominal fat were examined and free riboflavin, FMN, and FAD in plasma or liver were all analyzed. The growth depression, low plasma free riboflavin, liver free riboflavin, liver FMN, and liver FAD concentration were observed in the ducks fed the riboflavin-deficient basal diet ($P < 0.05$), and these adverse effects were alleviated by riboflavin supplementation. The growing ducks fed the basal diet with no supplementation of riboflavin had the lowest ADG, ADFI, G:F and breast meat yield among all ducks ($P < 0.05$) and these criteria showed linear or quadratic response to increasing dietary riboflavin ($P < 0.05$). On the other hand, dietary riboflavin influenced the status of this vitamin in growing ducks. The poorest growth performance of the riboflavin-deficient growing ducks was accompanied with the lowest content of riboflavin, FAD, and FMN in plasma or liver ($P < 0.05$) but these bad statuses were reversed by increasing dietary riboflavin in which the riboflavin and its derivative increased linearly or quadratically as dietary riboflavin increased ($P < 0.05$). According to the broken-line model, the riboflavin requirements (based on dietary total riboflavin) of male white Pekin ducks from 15 to 35 days of age for ADG, ADFI, G:F, plasma free riboflavin, liver free riboflavin, and liver FMN were 2.43, 2.48, 2.31, 3.57, 2.78, and 2.83 mg/kg, respectively.

Abbreviations: ADG, average daily weight gain; ADFI, average daily feed intake; G:F, gain to feed ratio; FMN, flavin mononucleotide; FAD, flavin adenine dinucleotide; HPLC, high performance liquid chromatography; SEM, the standard error of the mean.

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1. Introduction

Riboflavin is a water-solube vitamin and this vitamin is involved in a range of redox reactions in primary metabolic pathways and electron transfer processes (Powers, 2003; Lienhart et al., 2013), mainly as its biologically active coenzymes forms flavin mononucleotide (FMN) and flavin adenine dinucleotide (FAD). Like other avian species, riboflavin is needed by ducks and the deficiency of this vitamin could lead to high mortality, poor growth, and low retention of tissue riboflavin in starter Pekin ducks (Tang et al., 2013, 2014). Recently, the riboflavin requirements of modern starter Pekin ducks were estimated by Tang et al. (2013, 2014) and they confirmed that the riboflavin recommendation of NRC (1994) during the starter period (4 mg/kg) is still sufficient for modern Pekin duck strains. However, although the riboflavin recommendation of growing Pekin ducks (4 mg/kg) was provided by NRC (1994), no documentation was provided to support this value and the riboflavin requirements of growing ducks are virtually lacking until now. In chicks, the riboflavin requirements of birds decreased as age increased (Norris et al., 1936; Heuser et al., 1938) but this conclusion was not confirmed in ducks, which indicates that the riboflavin requirement of ducks during the growing period may be different from those during starter period. In practice, raising ducks is directed to meat production and carcass yield is usually considered to promote the benefit of duck production, which makes it necessary to evaluate the effects of riboflavin on growth performance and carcass traits of Pekin ducks when the riboflavin requirements of growing ducks were examined. On the other hand, in ducks, poor growth is usually accompanied with low plasma and liver riboflavin or FMN in riboflavin-deficient birds and thus the status of this vitamin could be indicated by tissue riboflavin and its derivative (Tang et al., 2013, 2014), which may reinforce the evaluation of the duck response to increasing dietary riboflavin. Therefore, the objective of the present study was to determine the effects of riboflavin on growth performance, carcass traits, and riboflavin status of growing Pekin ducks and to evaluate the requirements of this vitamin of these birds during growing period.

2. Materials and methods

2.1. Animals and housing

All procedures of the present study were approved by the animal care and use committee of the Institute of Animal Sciences of Chinese Academy of Agricultural Sciences. A total of 320 one-day-old male white Pekin ducks obtained from Pekin duck breeding center in Chinese Academy of Agricultural Sciences were randomly allotted to 16 raised plastic-floor pens with 20 birds per pen and then they were raised until 14 days of age. At 14 days of age, after fasting for 12 h, all the ducks were weighed individually and 288 ducks selected from these ducks were divided into six dietary treatments, each containing 6 replicate pens with 8 birds per pen. All pens had similar pen weight and these birds were free access to water and feed from 15 to 35 days of age. During this period, the lighting was continuous, and the temperature was kept at 33 °C from 1 to 3 days of age, and then it was reduced gradually to approximately 25 °C until 14 days of age and was kept at approximately 16–22 °C thereafter.

2.2. Diet

All the ducks were raised with common corn-soybean meal starter diet (Table 1) and this diet was formulated to meet the nutrient recommendations for starter ducks provided by Ministry of Agriculture of China (2012). The starter diet included 4 mg/kg of supplemental riboflavin. The basal diet during the growing period was formulated to be riboflavin-deficient (Table 1) and all nutrients except riboflavin met the recommendations for growing ducks provided by Ministry of Agriculture of China (2012). In order to produce six experimental diets, the basal diet were prepared as mash and then supplemented with 0, 1, 2, 3, 4, and 5 mg crystalline riboflavin/kg diet, respectively. All diets were cold-pelleted at room temperature. The crystalline riboflavin (purity, 99%) was obtained from (Sigma–Aldrich, St. Louis, MO, USA). The riboflavin content of this basal diet was determined by high performance liquid chromatography (HPLC) with a fluorescence detector and the value detected was 1.38 mg/kg. The riboflavin concentrations for the six experimental diets were calculated. These values are 1.38, 2.38, 3.38, 4.38, 5.38, and 6.38 mg riboflavin/kg of feed.

2.3. Sample preparation and data collection

At 35 days of age, the average daily weight gain (ADG), average daily feed intake (ADFI), and gain to feed ratio (G:F) of each pen were measured. Two ducks were selected randomly from each pen and bled by cardiac puncture. The blood were collected into heparin sodium-containing tubes and centrifuged at 1520 × *g* for 10 min to obtain plasma. These plasma samples were then stored at −20 °C until analyzed for riboflavin. Afterwards, these ducks were killed by CO_2 inhalation and immersed into hot water at 60 °C for 2 min. Then they were scalded, picked, and eviscerated manually. The breast meat (including both the pectoralis major and pectoralis minor), leg meat (including the thighs and the drum sticks), and abdominal fat were all removed from carcasses and weighed. The percentage yield for the breast meat, leg meat, and abdominal fat were expressed as relative weight to live BW at processing. The livers were removed from these birds and immediately stored at −20 °C until analyzed for riboflavin, FMN, and FAD.