# Effects of boron supplementation to diet on performance and boron deposition in broilers

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SUMMARY

The purpose of this study was to evaluate the effects of B supplementation to diets on performance and tissue accumulation in broilers. One hundred and fifty, 1-d-old broiler chicks (Ross 308) were divided into 5 groups with 3 replicates consisting of 10 animals each in the experiment. Boric acid was used as the B source. The dietary treatments consisted of the supplementation of the basal diets with 0, 5, 10, 20 and 40 mg B per kilogram diet, in the form of boric acid. B Supplementation did not affect performance traits (body weight gain, feed intake, and feed conversion ratio) during the experiment ($P>0.05$). It did not affect carcass percentage, liver B concentration and bone ash, but it affected liver weight and bone B concentration ($P<0.05$).

Keywords: Boron, broiler, mineralization, performance

## INTRODUCTION

Trace elements and their deficiencies or functions are of great importance in poultry nutrition. Boron (B) has been known as an essential element for higher plants since 1920's, but some studies have been focus on the possible role of B animal and human nutrition in recent years. Several studies have indicated that B is an important mineral for increased body weight and feed consumption, reduced mortality rate, normal cartilage and bone formation in broilers. Boron has been examined as a possible nutritional factor in calcium (Ca) metabolism and utilisation and, thus, as a factor in the development and maintenance of normal bone (Nielsen 1992). Bone-breaking strength and bone ash are often used to evaluate various dietary supplements, cage designs and animal densities for preventing bone breakage. For this reason, The National Research Council (NRC 1984) suggests that trace mineral supplements to chemically defined poultry diets should contain at least 2 mg/kg B, although the B requirement for the different categories of poultry has not been determined (Hunt 1989, Nielsen and Shuler 1992, Rossi et al 1993). Boron affects at least 26 enzymes

involved in substrate metabolism, insulin release, oxidation and immune systems (Hunt, 1998). The purpose of this study was to evaluate the effects of B supplementation to diets on performance and B concentration of some tissue in broilers.

## MATERIAL AND METHODS

One hundred and fifty, 1-d-old broiler chicks (Ross 308) were divided into 5 groups with 3 replicates consisting of 10 animals each in the experiment. Feed and drinking water were available ad libitum. The experimental period lasted for 42 day. Lighting was applied 23 hours/day. In the trial, chickens received basal diets (Table 1). Boric acid was used as the B source. The dietary treatments consisted of the supplementation of the basal diets with 0, 5, 10, 20 and 40 mg/kg B supplied from boric acid.

Table 1. Compositon of the basal diets

| Ingredients, % | Starter diet, (0-3 weeks) | Grower diet, (4-6 weeks) |
|---|---|---|
| Corn | 47.70 | 56.50 |
| Soybean meal (47.6 % CP)[1] | 30.60 | 28.00 |
| Sunflower meal (32.0 % CP)[1] | 9.80 | 6.07 |
| Vegetable oil (8800 ME kcal $kg^{-1}$) | 8.25 | 6.30 |
| Limestone | 1.26 | 1.36 |
| Dicalcium phospate | 1.61 | 1.13 |
| Salt | 0.35 | 0.30 |
| Premix[2] | 0.25 | 0.25 |
| DL-Methionine | 0.18 | 0.09 |
| TOTAL | 100.00 | 100.00 |
| Calculated nutrients | | |
| CP, % | 21.98 | 19.98 |
| ME, kcal $kg^{-1}$ | 3202 | 3202 |
| Ca, % | 0.999 | 0.900 |
| Non-Phytate P, % | 0.449 | 0.350 |
| L-Lysine, % | 1.119 | 1.018 |
| DL-Methionine, % | 0.500 | 0.380 |
| Methionine+Cystine, % | 0.902 | 0.751 |

[1] Analyzed value; [2] Supplied per kg of diets, vitamin A, 15000, ıu; vitamin K, 5.0 mg; vitamin $B_1$, 3 mg; vitamin $B_2$, 6 mg; vitamin $B_6$, 5 mg; vitamin $B_{12}$, 0.03 mg; niacin, 30 mg; D-biotin, 0.1 mg: calcium D- panthotenate, 12.0 mg; folic acid, 1.0 mg; choline cloride, 400 mg: manganese, 800 mg; iron, 35 mg; zinc, 50 mg; copper, 5.0 mg; iodine, 2 mg; cobalt, 0.04 mg; selenium, 0.15 mg. Supplementation of the basal diets with 0, 5, 10, 20 and 40 mg/kg B supplied from boric acid ($H_3BO_3$; 17.5 % B)

Initial weights of the birds were recorded at the beginning of the study. Body weight (BW) and feed intake (FI) were measured weekly, for

each pen, and then body weight gain (BWG) *per* pen was calculated. Feed conversion ratio (FCR) was also calculated weekly as kg of FI *per* kg of BWG. Mortality was recorded daily. On the last day of the trial, five birds of mixed sex in each replicate were slaughtered for determination of carcass characteristics and liver and bone samples were obtained to determine B concentrations. Tibia and liver B concentrations were determined by MarsXpress Technology Inside and atomic emission spectrophotometer (VISTA AX CCD Simultaneous ICP-AES).

Data were analyzed by a one-way analysis of variance for the level of supplemental B in the diet (Minitab Reference Manual, Release 10.1). Those response variables resulting in a significant F value were further analyzed using Duncan's multiple range test (Duncan 1955).

## RESULTS AND DISCUSSION

Body weight gain, FI and FCR data are shown in Table 2. Supplementation of B did not affect performance traits during the experiment ($P>0.05$). Supplementation of B did not affect on carcass percentage, liver B concentration and bone ash. But supplemental B affected liver weight and bone B concentration ($P<0.05$) at the end of trial. There were significantly differences between group 2 and other groups for liver weights. Bone B concentrations were significantly affected by dietary B concentrations.

Table 2. Body weight gain, feed intake and feed conversion ratio of broiler chickens fed boron supplemented diets

| Groups* | Body Weight Gain, g | | | Feed Intake, g | | | Feed conversion ratio, Feed, g / Gain, g | | |
|---|---|---|---|---|---|---|---|---|---|
| | Weeks | | | | | | | | |
| | 0-3 | 4-6 | 0-6 | 0-3 | 4-6 | 0-6 | 0-3 | 4-6 | 0-6 |
| 1 | 433.1 | 1348.1 | 1781.3 | 753.4 | 2997.9 | 3751.3 | 1.60 | 2.30 | 1.95 |
| 2 | 457.8 | 1471.2 | 1929.0 | 764.7 | 3177.5 | 3942.2 | 1.55 | 2.20 | 1.88 |
| 3 | 407.3 | 1264.1 | 1671.0 | 727.4 | 2655.0 | 3382.0 | 1.70 | 2.16 | 1.93 |
| 4 | 418.1 | 1170.0 | 1588.1 | 751.0 | 2607.5 | 3358.6 | 1.66 | 2.41 | 2.03 |
| 5 | 426.7 | 1318.6 | 1745.3 | 733.2 | 2743.4 | 3476.6 | 1.62 | 2.16 | 1.89 |
| SEM | 15.02 | 77.36 | 83.6 | 20.60 | 114.6 | 118.0 | 0.058 | 0.128 | 0.070 |

* 1: control, 2: 5 mg/kg B, 3: 10 mg/kg B, 4: 20 mg/kg B, 5: 40 mg/kg B

Rossi *et al.* (1990) investigated the effects of four B levels (0, 20, 80 and 320 ppm) combined with two levels of riboflavin (4.4 and 17.6 ppm) in the diets of broiler chickens from 1 to 49 days. At 21 days of age, FI BW and mortality were significantly lower for broilers given 320 ppm B in the diet than other diets. Besides, broilers fed diets containing B had better feed conversion in the experimental period when compared to the control group (0 ppm B). The three tested B levels had no effect on tibia

weight and ash content. Elliot & Edwards (1992) evaluated different levels of B supplementation in the diet (0, 5, 10 and 20 ppm), as well as the possible interaction between B, calcium (0.65 and 0.90%) and cholecalciferol (110 and 1,100 ICU). Boron did not affect BWG, FCR or the incidence of tibial dyschondroplasia, but had a quadratic effect on bone ash (decreased ash % starting from 10 ppm). Boron requirements for broiler chickens in the first 21 days of age were evaluated in two trials with different supplementation levels: 0, 5, 40, 80 and 120 ppm in the first experiment and 0, 60, 120, 240 and 360 ppm in the second experiment (Rossi *et al.*, 1993). Supplementation with 5 ppm B resulted in a positive response; broilers were heavier and had more resistance to tibia breaking strength. On the other hand, broilers fed higher concentration of boron (360 ppm) in the second trial were lighter than those broilers given non-supplemented diet. Neither B levels in the liver nor broiler development were affected by diets containing more than 240 ppm B. Wilson & Ruszler (1997) studied the effects of boron supplementation in broiler diets and suggested that the addition of 50 ppm B improved some bone characteristics (resistance to breaking, shear force and ash percentage) but did not influence weight gain.

Table 3. Carcass yield, liver weight, some tissues B concentrations and bone ash of broiler chickens fed boron supplemented diets

| Groups* | Carcass yield, % | Liver weight, g | Boron, mg/kg | | Bone Ash, % |
|---|---|---|---|---|---|
| | | | Bone | Liver | |
| 1 | 72.0 | 41.0$^{b}$ | 1.93$^{d}$ | 2.29 | 38.6 |
| 2 | 70.5 | 62.0$^{a}$ | 2.24$^{c}$ | 2.36 | 38.8 |
| 3 | 67.0 | 45.0$^{b}$ | 2.40$^{b}$ | 2.54 | 41.1 |
| 4 | 71.5 | 31.0$^{b}$ | 2.56$^{a}$ | 2.44 | 41.3 |
| 5 | 70.0 | 34.5$^{b}$ | 2.41$^{b}$ | 2.47 | 41.8 |
| SEM | 1.22 | 4.57 | 0.352 | 0.059 | 2.39 |

* 1: control, 2: 5 mg/kg B, 3: 10 mg/kg B, 4: 20 mg/kg B, 5: 40 mg/kg B

a. b. Means with different minuscule in the same column are significantly different at P<0.05.

## CONCLUSIONS

In this study, performance parameters were not influenced of B supplementation in broilers. The liver weights and bone B concentrations were affected by dietary B levels. It is concluded that the addition of at least 5 ppm B improved bone characteristics in broilers.

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