



Effects of boric acid supplementation on egg production and quality of Japanese quails (*Coturnix coturnix Japonica*)

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Boron is a trace element that is turning out to be essential for animals and it is abundant in nature as boric acid and borate (Olgun *et al.* 2009). Boron is an essential element for higher plants and plays a role in the metabolism of mineral, bone, enzymes and steroid hormones and would thus have an influence on animal (Uysal *et al.* 2009, Mizrak *et al.* 2010 and Sizmaz 2010). Some studies suggested that boron plays an important role in the metabolism of macro-minerals in broilers, mainly calcium, improving the balance of this mineral and bone strength, and reducing losses due to bone fractures (Elliot and Edwards 1992, Rossi *et al.* 1993, Dupre *et al.* 1994, Chapin *et al.* 1996).

Although boron is not considered essential for poultry or most animals, the inclusion of 2 ppm in poultry feed was recommended by NRC (1984), irrespective of poultry category or type of production. Such suggestions are not present in the requirement for poultry in NRC (1994).

Rossi *et al.* (1993) suggested that the addition of 5 ppm boron resulted in a positive response in terms of body weight gain and resistance to tibia breaking strength. Qin and Klandorf (1991) indicated that boron decreased egg production but did not affect shell quality. Studies on boron in poultry revealed contradictory results. Wilson and Ruszler (1998) found that bird body weight, feed intake, egg weight and egg production decreased at 400 mg/kg boron. However, Kurtoglu *et al.* (2002) observed no differences between groups of laying hens regarding feed intake, feed conversion efficiency, body weight, egg weight and specific gravity of eggs. Yesilbag and Eren (2008) reported that dietary boron supplementation reduced the percentage of cracked eggs by improving egg shell thickness and egg shell breaking strength

in aged laying hens. Olgun *et al.* (2009) reported that boric acid supplementation negatively affected egg weight, feed intake and egg mass in molted laying hens. Mizrak *et al.* (2010) found that boron supplementation at 25 and 50 mg/kg improved egg quality.

In fact, there is no recommended level of boron for daily intake for poultry (NRC 2001). However, it is well known that boric acid antagonize riboflavin metabolism in chickens (Anonymous 2001). Therefore, the present study was undertaken to assess whether dietary supplemental boron as boric acid could affect egg production and egg shell quality in Japanese quails (*Coturnix coturnix japonica*) known as a highly productive poultry species in terms of eggs.

Female Japanese quails (135) at 8 weeks of age were divided into 3 groups, 1 control and 2 experimental groups. Each treatment group contained 3 subgroup containing 15 birds each. Before trial, 1-week adaptation period was applied. Commercial maize-barley based standard layer diets were used as basal diets for the control (A), basal diets were supplemented with 200 (B) and 400 ppm (C) boric acid (Table 1) to supply boron.

The experimental period was 8 weeks following standard managemental conditions. Quails were benefited from day light (average 16h/day) and water was continuously available.

Laying performance was determined daily by measuring feed intake, feed conversion efficiency, egg production (number and weight). Feed conversion efficiency was calculated as kilograms of feed to kilograms of egg. Length, width, shape index (width/length), shell weight, shell thickness of each egg obtained on the fourth day of every week were determined following standard procedure. Shell samples from top, middle and bottom sites of the egg were measured for thickness using a micrometer.

The data with respect to laying performance and egg quality were subjected to analysis of variance using GLM (General Linear Model) procedure of SAS (1996), and means were separated using Duncan's New Multiple Range Test (Bek and Efe 1998).

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Table 1. Composition and nutrient contents of the basal diet

Ingredients	g/kg	Nutrient contents***	
Maize	300.00	Dry Matter%	88.22
Barley	198.82	ME (Kcal/kg)	2605.11
Wheat bran	109.54	Crude Protein%	17.00
Sunflower meal	80.73	Ether Extract%	4.70
Limestone	71.52	Crude Fiber%	6.00
Poultry offal meal	60.00	Crude Ash%	13.00
Full-fat	43.88	Lysine%	0.76
Meat and bone meal	41.29	Methionine + cystine%	0.66
Wheat middlings	43.43	Ca, %	3.50
Soybean	30.08	Available P%	0.48
Corn gluten meal	10.00		
Soda	2.51		
Vitamin premix*	2.00		
Bentonite	2.00		
Toksisep	2.00		
Mineral Premix**	1.50		
Alimet	0.70		

* Provided by per kg of diet: 6000000 IU Vitamin A; 800000 IU Vitamin D₃; 14000 mg Vitamin E; 1600 mg Vitamin K₃; 1250 mg Vitamin B₁; 2800 mg Vitamin B₂; 8000 mg Niacin; 4000 mg Ca-D-Pantothenate; 2000 mg Vitamin B₆; 6 mg Vitamin B₁₂; 400 mg Folic Acid; 18 mg D-Biotin; 20000 mg Vitamin C; 50000 mg Choline Chloride

** Provided by per kg of diet: 80000 mg Manganase; 60000 mg Iron; 60000 mg Zinc; 5000 mg Copper; 200 mg Cobalt; 1000 mg Iodine; 150 mg Selenium.

The boric acid supplementation to the diet had no significant ($P < 0.05$) effects on egg production, egg shell weight, egg shape index (Table 2). However, egg shell thickness was reduced by 400 ppm boric acid. The addition of boric acid (400 ppm) to the diets caused a significant ($P < 0.05$) increase in mean egg weight compared to the control group. Feed conversion efficiency improved by 200 ppm boric acid supplemented group ($P < 0.05$). Egg shell thickness decreased significantly with the addition of 200 and 400 ppm boric acid ($P < 0.05$).

In this study, supplementing boric acid to the diet did not affect ($P < 0.05$) feed intake of quails. But quails given diet containing 400 ppm boric acid had greater cumulative feed intake than the other groups. Our results are in line with the results of Ayasan *et al.* (2002) who reported that the Japanese quails fed on rations containing boric acid had no significant difference in feed intake of groups receiving 150 ppm boric acid. In contrary, Wilson and Ruszler (1996, 1998) and Eren *et al.* (2004) found that feed intake was significantly decreased for birds fed on the diet containing the 400 mg/kg concentration of boron. Fassani *et al.* (2004) also found that feed intake was affected linearly and reduced as the boron level increased in the diets.

In the present study, feed conversion efficiency was significantly ($P < 0.05$) affected by supplementation of boric acid (Table 2). In contrast to our results, Armstrong and

Table 2. The effects of dietary boric acid on performance and egg shell quality of laying Japanese quails

Parameters	Dietary boric acid (ppm)		
	0 (Group A)	200 (Group B)	400 (Group C)
Feed intake (g/bird/ 56 days)	1289.7 ±4.81	1349.8 ±5.33	1363.9 ±8.22
Mean egg weight (g/egg)	13.85 ±0.11 ^b	13.73 ±0.11 ^b	14.15 ±0.09 ^{a*}
Egg production (%)	82.31 ±5.74	90.36 ±3.00	79.36 ±2.91
Number of eggs (56 days)	534	613	495
Egg mass (g/bird/ 56 days)	7395	8416	7004
Feed conversion efficiency	3.19 ±0.14 ^{ab}	3.04 ±0.07 ^b	3.50 ±0.15 ^a
Egg shell weight (g/egg)	1.51±0.28	1.53±0.03	1.56±0.03
Egg shell thickness (μ)	231.8±3.37 ^a	225.5±3.23 ^{ab}	220.3±2.58 ^b
Egg shape index ((width/ length)× 100)	79.05±0.45	80.05±0.20	79.85±0.35

a,b means within rows with different superscripts differ significantly ($P < 0.05$).

Spears (2001), Ayasan *et al.* (2002), Kurtoglu *et al.* (2002), Eren *et al.* (2004) reported that the feed conversion efficiency was not affected by supplemental boron. Similarly, feed conversion efficiency was not affected by 80 mg/kg supplemental boron in broilers (Elliot and Edwards 1992). Fassani *et al.* (2004) found that the level of 57 ppm boron was adequate for weight gain without affecting feed conversion efficiency in broiler.

Egg production (%) increased as a result of boric acid supplementation especially 200 ppm by laying quails. Egg production in group A was 82.31 % and in group B was 90.36 and in group C was 79.36 %. No significant difference was observed among groups ($P > 0.05$). Wilson and Ruszler (1995, 1996, 1998) also found no significant increase in egg production in younger laying hens by supplementing boric acid at the levels of 0–250 ppm and 0–200 ppm, respectively. These results contrast with those of Qin and Klandorf (1991) where boron supplementation at 100 ppm caused a decrease in egg production in one of two experiments and it was suggested that the toxic effect of boron on egg production may be associated with the age of the birds. Eren *et al.* (2004) also found that egg production was reduced in the 400 mg/kg boron supplemented group.

Average egg weight increased significantly ($P < 0.05$) in the groups, which contained 400 ppm boric acid. Moreover, eggs from laying quails fed on the diet containing the 400 ppm concentration of boric acid were about 2.12% heavier than the eggs from the control quails. Wilson and Ruszler (1996) and Kurtoglu *et al.* (2002) stated that the addition of boron to diets had no effect on egg weight. This is in contrast

with Eren *et al.* (2004), who reported that egg weight decreased significantly by 400 ppm.

Dietary boric acid had no effect on egg shell weight, which is in contrast to the results of Wilson and Ruszler (1996) who claimed that boric acid supplementation caused a decrease in egg shell weight.

Egg shape index was similar among the groups (Table 2). The group receiving 200 ppm supplemental boric acid attained the highest egg shape index, while the group receiving 0 ppm boric acid had highest egg shell thickness ($P < 0.05$). In contrary with Qin and Klandorf (1991), the addition of boron supplementation to diets did not affect on egg shell thickness. Therefore, further studies with lower levels of boron in the form of boric acid supplementation may be more valuable for the field applications.

These data revealed that boric acid supplementation to the diet affected mean weight, egg shell thickness, and feed conversion efficiency in Japanese quails.

SUMMARY

The present study was carried out to determine whether dietary boric acid would affect egg production parameters and egg shell quality of Japanese quail (*Coturnix coturnix japonica*). In the study, 135 female Japanese quails at 8 weeks of age were used. The quails were divided into 3 groups randomly, each treatment group contained 3 subgroup containing 15 birds each. Commercial maize-barley based standard layer diets were formulated as basal diets for the control treatment, basal diets were supplemented with 200 and 400 ppm boric acid. The experiment lasted 8 weeks. The results obtained in this experiment showed that boric acid supplementation to the diet significantly affected egg weight, egg shell thickness and feed conversion efficiency, but there was no significant difference between the control and the boric acid supplemented groups in feed intake, egg production, egg shell weight, egg shape index.

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