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RESEARCH ARTICLE

Effects of Dietary Boric Acid and Ascorbic Acid Supplementation on Performance, Some Blood and Bone Parameters in Broilers [1]

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Summary

This study was carried out to determine the effects of boric acid (17.5% boron) and ascorbic acid supplementation on performance, selected blood and bone parameters, carcass yield and malondialdehid (MDA) levels of broilers. The experiment lasted in 42 days. Totally 240 one-day old male Ross 308 broilers were housed at a density of 15 chickhens in each of 16 experimental plots using a completely randomized block experimental design. Diets were based on maize and soybean meal. Experimental groups divided into one control (CON) and 3 experimental groups. The experimental diets supplemented with 200 ppm ascorbic acid (AA) for the first group, 175 ppm boric acid (BA) for the second group and 200 ppm ascorbic acid plus 175 ppm boric acid combination (AABA) for the third group. At the end of experiment period there were statistically significant differences ($P<0.05$) between control and the treatment groups about body weight, body weight gain and feed conversion ratio for first 3 weeks of the experimental period, but there were no statistically different for feed intake. Carcass yield increased with additives especially with boron supplementation ($P<0.05$). Total protein, cholesterol, trigliseride concentration and ALT activity were not affected by addition of feed additives but AST activity increased in BA group while it was reducing in AA and AABA groups. There were also statistically significant differences for left tibia P levels ($P<0.05$) and plasma, liver MDA levels ($P<0.001$). There were no statistically significant differences between control and the treatment groups for tibia ash, Ca levels and some strength parameters. As a result; it can be concluded that boric acid and ascorbic acid supplementation did have positive effect on performance in 0-21 days of the experimental period and also on MDA levels about lipid peroxidation activity, bone mineralization and hot carcass yield studied in the experiment. It is inferred that it will be usefull if these feed additives are studied again at different levels and under different conditions.

Keywords: *Ascorbic acid, Boric acid, Broiler, MDA, Performance, Tibia*

Broyler Rasyonlarına İlave Edilen Borik Asit ve Askorbik Asidin Performans, Bazı Kan ve Kemik Parametreleri Üzerine Etkileri

Özet

Bu çalışma broyler rasyonlarına borik asit ve askorbik asit ilavesinin performans, bazı kan ve kemik parametreleri, karkas kalitesi ve MDA düzeyleri üzerine etkilerini belirlemek amacıyla gerçekleştirilmiştir. Araştırma 42 gün sürdürülmüştür. Araştırmada 16 bölmenin her birinde 15 adet günlük yaşta erkek 240 adet broyler civciv kullanılmıştır. Rasyonun temelini soya ve mısır oluşturmuştur. Bir kontrol ve 3 deneme grubu oluşturulmuş olup, kontrol grubuna herhangi bir ilave yapılmamıştır. Deneme grupları yemlerine ise sırasıyla 200 ppm askorbik asit, 175 ppm borik asit ve 200 ppm askorbik asit + 175 ppm borik asit ilavesi gerçekleştirilmiştir. Araştırma sonuçlarına göre; ilk 3 haftada kontrol grubu ve deneme grupları arasında canlı ağırlık, canlı ağırlık artışı ve yemden yararlanma oranı bakımından istatistiksel farklılıklar görülmüştür ($P<0.05$). Ancak yem tüketimleri arasında bir fark bulunamamıştır. Karkas randımanı özellikle bor ilaveli grupta artış göstermiştir ($P<0.05$). Toplam protein, kolesterol, trigliserit konsantrasyonları ve ALT aktivitesi etkilenmezken, AST aktivitesi borik asit ilaveli grupta artmıştır. Tibia P düzeyleri ile karaciğer ve plazma MDA düzeyleri arasında da istatistik açısından önemli farklılıklar elde edilmiştir ($P<0.001$). Kemik kül, Ca ve bazı mukavemet parametreleri bakımından da guplar arasında bir fark görülmemiştir. Sonuç olarak; borik asit ve askorbik asit takviyesi 0-21 günlerde performans üzerine ve aynı zamanda lipit peroksidasyonu bakımından MDA düzeyine, kemik mineralizasyonuna ve sıcak karkas randımanına olumlu etkilerde bulunmuştur. Karaciğer ve but kası bor düzeyleri bakımından da bor ilaveli gruplarda beklenen artışın söz konusu olduğu dikkati çekmiştir. Bu iki yem katkısının farklı dozlarda ve farklı koşullarda yapılacak çalışmalar sayesinde hayvanlar üzerinde irdelenmesinin faydalı olacağı sonucuna varılmıştır.

Anahtar sözcükler: *Askorbik asit, Borik asit, Broyler, MDA, Performans, Tibia*

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INTRODUCTION

The using of boron compounds in livestock sector are essential for country economy [1]. Boron was found in nature with its compound, especially as boric acids and borates [2,3]. In recent years, there are many investigations about using boron compounds in animal nutrition. Altough high levels of boron has fatal effect, in defficiency of boron, it is seen that inadequate growth and abnormal bone devolepment [4]. However present day it isn't certain that this element is essential for human and animals. Elliot and Edwards [5] have studied with boron (0, 20, 40, 80 ppm) in broilers and they reported that boron increased body weight and did not alter plasma mineral levels. In same study they have used 0, 5, 10 and 20 ppm boron and boron increased bone ash level. When boron levels increased in diets, body weight, tibia strength, liver and muscle boron concentration also increased [6]. Boric acid complexes are found in body structure. For instance; carbohydrates (glucose and polisaccarides), nucleotides (adenosine monophosphate and niacineamide adenindinükleotide), vitamins (ascorbic acid, pyridoxine, ryboflavine) [7]. So boron was used with ascorbic acid in current study and it was aimed to constitude an organoboron.

Ascorbic acid is a chemical name of vitamin C. It has plenty of isomers and vitamin C is equal to L-ascorbic acid. Because only this isomer (L-ascorbic acid) has a biological activitiy [8]. At general conditions ascorbic acid is synthesised sufficiently from kidney for metabolism in poultry [9]. Some metal ions have an important role for fragmentation of ascorbic acid and ascorbic acid composes a chelat with some metal ions [8]. It forms a bond with inorganic elements. When boron binds to an organic material, it is called organoboron. A large number of organoboron compounds are known and many are useful in organic synthesis [10]. According to Sahin et al.[11] 250 mg L-ascorbic acid increased body weight gain, feed intake, feed efficiency, hot and cold carcass weight, decreased serum cholesterol levels. Ascorbic acid (200 ppm) also increased performance parameters and MDA (malondialdehit) levels and decreased SOD (superoxide dismutase) levels [12].

The objective of this research was to evaluate the effects of boric acid and ascorbic acid supplementation on performance, carcass traits some blood and bone parameters and MDA level in broilers.

MATERIAL and METHODS

Animals, Experimental Design and Diets

In this study totally 240 one-day old male broiler chicks housed at a density of 15 chickens in each of 16 experimental plots. Experimental groups divided into one control and 3 treatment groups. The experimental diets supplemented with 200 ppm ascorbic acid for the first group, 175 ppm boric acid for the second group and 200 ppm ascorbic acid plus 175 ppm boric acid combination for the third group. Experiment period lasted in 42 days. Diets were based on maize, full fat soybean and soybean meal. Feed and water intake were offered *ad libitum*. Nutrient analysis in raw metarial and mixed feeds were determined according to AOAC [13] procedures *(Table 1)*. The formula recommended by TSE (Turkish Standards Institute) [14] was used to calculate the levels of metabolisable energy. Feed boron levels were measured by Thermo X-SERIES2 ICP-MS. This trial has been approved by Ankara University Animal Experiments Local Ethics Committee with 2009-38-174 number.

Performance and Biochemical Measurements

During the experimental period, the performance of the broilers was evaluated by weekly recording body weight (BW), body weight gains (BWG), feed intake (FI) and feed conversion ratio (FCR). FCR was calculated as the amount of feed consumed per unit of body weight gain. Mortality was recorded daily.

At the end of the experiments in each subgroup 3 broiler chicks were chosen randomly in each subgroup and slaughtered by cervical dislocation to determine the hot carcass weights and yields and also the absolute and relative weights of some visceral organs (liver, heart, spleen, gizzard, abdominal fat, bursa of Fabricius). Blood samples were obtained from each bird to the tubes with anticoagulant and without anticoagulant while animals were slaughtered. These samples were allowed to clot at room temperature for 6 h and then they were centrifuged at 3.000 rpm for 10 min at room temperature. Sera and plasma were carefully harvested and sera were stored at -20°C, plasmas were stored at -80°C until analysis. Serum total protein, cholesterol, tyrigliceride levels were detected with a commercial kit (Teco Diagnostic) by autoanalyser. AST and ALT levels were also detected with a commercial kit (Erba Mannheim XL System Packs) by autoanalyser. Boron levels in serum were determined by using of ion chromatography (ICS) (Dionex 3000, USA) [15].

Plasma and also liver tissue MDA concentration was measured with high plessure liquid cromotography (HPLC, Shimadzu, Tokyo, Japan) [16], at 250 nm Interstil 5µ C-18 (15 x 4.6 mm) column was used for this analysis.

Liver and thigh muscle boron level were measured by using Thermo X-SERIES2 ICP-MS.

At the end of the experiments 3 broiler chicks in each subgroup were slaughtered humanly and their left and right tibias were dissected. The meat on the bones were removed physically and fat, using an ether solvent. The left tibias were then dried at 105°C for 2 h. The bones were

Table 1. *Ingredients and chemical composition of mixed feeds used in the experiment*
Tablo 1. *Araştırmada kullanılan deneme karma yemlerinin bileşimi ve kimyasal kompozisyonu*

Diet (%)	Starter Diet 0-14 days	Grower Diet 15-28 days	Finisher Diet 29-42 days
Corn	50.50	55.00	57.60
Full fat soybean	12.50	11.00	15.00
Soybean meal	29.00	26.00	19.00
Meat bone meal	3.00	2.00	3.00
Vegetable oil	1.50	3.00	3.00
Dicalcium phosphate	1.00	0.70	0.75
Limestone	1.00	1.00	0.50
DL-Methionine	0.20	0.25	0.20
L-Lysine HCL	0.10	0.05	-
L-Threonine	0.20	0.05	0.05
Vitamin-Mineral Premix[1]	0.30	0.25	0.20
Common Salt	0.30	0.30	0.30
Filling metarial (clinoptilolite)	0.40	0.40	0.40
Calculated Composition			
Metabolic energy, (MJ/kg)	12.64	13.21	13.48
Crude protein, %	23.10	20.90	20.30
Analysed Composition			
Metabolic energy, kcal/kg	12.65	13.26	13.43
Crude protein, %	23.00	21.0	20.34
Boron, ppm	23.50	21.17	18.58

[1] ***Vitamin-Mineral Premix:*** *Supplies per kg Vit. A 13.500.000 IU/kg, Vit. D_3 3.000.000 IU/kg, Vit. E 50.000 mg/kg, Vit. K_3 5.000 mg/kg, Vit. B_1 3.000 mg/kg, Vit. B_2 6.000 mg/kg, Vit. B_6 4.000 mg/kg, Vit. B_{12} 30 mg/kg, pantotenik acid 10.000 mg/kg, folic acid 1.000 mg/kg, niasin 40.000 mg/kg, biotin 50 mg/kg, BHT 10.000 mg/kg, manganese 80.000 mg/kg, iron 60.000 mg/kg, zinc 60.000 mg/kg, cupper 5.000 mg/kg, iode 1.000 mg/kg, cobalt 200 mg/kg, selenium 200 mg/kg*

ashed overnight in a furnance 610°C to determine ash [13]. Bone samples were digested in closed teflon vessels using microwave heating (BERGHOF, MWS-2, Germany), whereupon the boron content was determined through Thermo X-SERIES2 ICP-MS and Ca and P content was determined through spektrometer (Shimadzu, Tokyo, Japan, UV-1208). The right tibias were weighted and measured length. Bone weight/length index were indicated that tibia weights ratio to tibia lengths [17]. Robustness index was calculated with the formule (Robustness index= cubic surd of bone length/bone weight). Some fracture tests were measured by Zwick-Roel Z020 with 155213/2002 series number in material test apparatus with Lloyd TG 18 type A26129204 series number three point bending equipment [18].

Statistical analysis

Statistical analysis were done using SPSS programme (SPSS Inc., Chicago, IL, USA). One-way ANOVA was performed to examine differences among groups. The significance of mean differences between groups was tested by Duncan [19]. Values were given as mean±standard error. Level of significance was taken as $P<0.05$ [20].

RESULTS

The effects of supplemental dietary boric acid and ascorbic acid on body weight of broilers are shown in *Table 2*, body weight gain, feed intake and feed conversion ratio are shown in *Table 3*. Body weight ($P<0.001$) and body weight gain ($P<0.01$) increased and feed efficiency improved ($P<0.05$) greatly during the first three weeks in broilers fed supplemental diets compared with the broilers fed to control diet. Supplemental boric acid and ascorbic acid significantly increased hot carcass yield ($P<0.05$); however these effect was not shown carcass and some internal organ weights ($P>0.05$) *(Table 4)*. The effects of boric acid and ascorbic acid supplementation on serum total protein, cholesterol, triglyceride concentrations, AST and ALT avtivities are shown in *Table 5*. Seperately or as a combination, supplemental boric acid and ascorbic acid did not effect total protein, cholesterol, triglyceride concentrations and ALT activity ($P>0.05$). While ascorbic acid reduced AST activity, boric acid increased ($P<0.05$) that activity. Bone qualities are shown in *Table 6*. Bone phosphorus (P) ($P<0.05$) and boron contents ($P<0.001$)

Table 2. *Effects of boric acid and ascorbic acid on body weight, g (x ± Sx)*
Tablo 2. *Borik asit ve askorbik asidin ortalama canlı ağırlık üzerine etkileri*

Age (week)	n	Control	n	Ascorbic acid	n	Boric acid	n	Ascorbic acid + Boric acid	P
1	59	150.20^{b}±1.74	60	162.23^{a}±2.79	60	157.77^{a}±2.04	60	160.90^{a}±1.71	0.000***
2	59	402.85^{c}±6.30	59	451.75^{a}±6.26	58	431.35^{b}±5.33	60	439.10^{ab}±6.01	0.000***
3	59	804.07^{b}±14.40	59	873.64^{a}±12.45	58	854.40^{a}±9.74	60	869.67^{a}±11.96	0.000***

a, b, c; *Mean values within a row with no common superscript differ significantly, *** P<0.001*

Table 3. *Effects of boric acid and ascorbic acid on weight gain, feed intake and feed conversion ratio (x ± Sx)*
Tablo 3. *Borik asit ve askorbik asidin ortalama canlı ağırlık artışı, yem tüketimi ve yem değerlendirme sayısı üzerine etkileri*

Parameters	Control	Ascorbic acid	Boric acid	Ascorbic acid + Boric acid	P
Body weight gain, g					
0-21 days	760.18±15.06^{b}	830.19±12.64^{a}	810.57±5.84^{a}	825.88±12.44^{a}	0.005**
21-42 days	1589.10±44.09	1507.10±15.98	1559.65±52.88	1508.42±41.09	0.438
0-42 days	2349.28±35.57	2337.39±28.35	2370.22±53.53	2334.30±51.42	0.934
Feed intake, g					
0-21 days	1355.25±19.99	1354.41±17.58	1370.51±12.42	1330.28±20.82	0.492
21-42 days	3168.94±54.43	3133.77±72.63	3107.54±45.63	3035.58±56.94	0.451
0-42 days	4524.18±74.13	4488.19±70.17	4478.05±50.84	4365.87±76.64	0.430
Feed conversion ratio, g feed intake/g body weight gain					
0-21 days	1.79±0.06^{a}	1.63±0.03^{b}	1.69±0.02^{ab}	1.61±0.03^{b}	0.015*
21-42 days	2.00±0.02	2.08±0.04	2.00±0.04	2.01±0.03	0.277
0-42 days	1.93±0.00	1.92±0.02	1.89±0.02	1.87±0.02	0.162

a, b, c; *Mean values within a row with no common superscript differ significantly, ** P<0.01, * P<0.05, n=4*

Table 4. *Effects of boric acid and ascorbic acid on carcass qualities (x ± Sx)*
Tablo 4. *Borik asit ve askorbik asidin karkas sonuçları üzerine etkileri*

Parameters	Control	Ascorbic acid	Boric acid	Ascorbic acid + Boric acid	P
Slaughter weight, g	2433.75±8.70	2483.33±19.21	2440.83±19.84	2442.92±18.17	0.257
Hot carcass weight, g	1773.33±17.99	1812.08±12.74	1812.50±14.38	1790.42±20.48	0.292
Hot carcass yield, %	72.85±0.31^{b}	72.98±0.31^{b}	74.27±0.38^{a}	73.28±0.45^{ab}	0.037*
Liver weight, g	46.83±1.71	47.17±1.32	44.92±1.42	47.50±2.46	0.739
Liver yield, g/100 g BW	1.92±0.07	1.90±0.05	1.84±0.05	1.94±0.10	0.735
Heart weight, g	12.83±0.72	12.50±0.74	12.58±0.54	12.25±0.49	0.933
Heart yield, g/100 g BW	0.53±0.03	0.50±0.03	0.52±0.02	0.50±0.02	0.895
bursa Fabricius weight, g	3.50±0.29	3.36±0.43	3.55±0.39	2.92±0.40	0.625
bursa Fabricius yield, g/100 g BW	0.14±0.01	0.14±0.02	0.15±0.02	0.12±0.02	0.626
Gizzard weight, g	43.42±2.07	45.92±2.05	44.00±0.89	42.25±1.57	0.500
Gizzard yield, g/100 g BW	1.79±0.09	1.85±0.08	1.80±0.04	1.73±0.06	0.689
Abdominal fat weight, g	29.46±3.15	25.83±3.76	30.00±2.12	29.58±3.04	0.751
Abdominal fat yield, g/100 g BW	1.21±0.13	1.04±0.15	1.23±0.09	1.21±0.12	0.662
Spleen weight, g	3.83±0.39	3.25±0.31	2.92±0.19	2.92±0.29	0.118
Spleen yield, g/100 g BW	0.16±0.02	0.13±0.01	0.12±0.01	0.12±0.01	0.118

a, b; *Mean values within a row with no common superscript differ significantly, * P<0.05, n=12,* ***BW:*** *Body weight*

were significantly increased with supplemental boric acid and ascorbic acid and tibia vertical diameter was increased with each supplemental treatment group compared with the control group. However; crude ash, calcium (Ca) level and some bone strength parameters were not affected from these addititon (P>0.05). There

Table 5. *Effects of boric acid and ascorbic acid on some blood parameters (x ± Sx)*
Tablo 5. *Borik asit ve askorbik asidin bazı kan parametreleri üzerine etkileri*

Parameters	Control	Ascorbic acid	Boric acid	Ascorbic acid+Boric acid	P
Total protein, g/dl	2.98±0.23	3.06±0.18	2.75±0.08	3.23±0.21	0.348
Cholesterol, mg/dl	127.80±3.23	124.43±5.75	128.16±3.59	126.10±5.23	0.981
Triglyceride, mg/dl	44.55±3.57	42.17±2.00	47.11±2.20	44.88±1.96	0.594
AST, IU/L	420.88±30.82^{ab}	361.15±15.02^{b}	442.39±24.92^{a}	354.60±19.15^{b}	0.028*
ALT, IU/L	26.41±1.67	26.21±2.71	25.79±4.10	21.58±1.99	0.570

a, b; *Mean values within a row with no common superscript differ significantly, * P<0.05, n=8*

Table 6. *Effects of boric acid and ascorbic acid on some bone parameters (x ± Sx)*
Tablo 6. *Borik asit ve askorbik asidin bazı kemik parametreleri üzerine etkileri*

Parameters	Control	Ascorbic acid	Boric acid	Ascorbic acid + Boric acid	P
Crude ash, % [1]	55.83±0.32	55.93±0.36	56.56±0.32	56.61±0.52	0.352
Ca, % [2]	17.36±1.66	19.57±1.69	18.06±1.50	18.82±1.20	0.760
P, % [2]	8.30±0.61^{b}	9.33±0.33^{ab}	9.39±0.34^{ab}	10.40±0.39^{a}	0.016*
Ca/P [2]	2.28±0.37	2.12±0.19	1.95±0.18	1.83±0.13	0.544
B, ppm [1]	1.03±0.01^{d}	2.05±0.001^{c}	10.76±0.46^{a}	9.73±0.15^{b}	0.000***
Weight, g [1]	13.31±0.47	12.79±0.37	13.07±0.45	12.83±0.20	0.797
Length, cm [1]	9.98±0.04	9.88±0.06	10.09±0.12	9.99±0.13	0.483
Weight / Length index, mg/mm [1]	133.27±4.31	129.30±3.27	129.46±3.87	128.21±2.37	0.759
Robustness index [1]	4.22±0.04	4.23±0.03	4.29±0.05	4.27±0.03	0.551
Horizontal diameter, mm [1]	9.46±0.16	9.48±0.20	8.93±0.19	9.23±0.20	0.142
Vertical diameter, mm [1]	8.24±0.16^{a}	7.83±0.17^{ab}	7.45±0.12^{b}	7.99±0.22^{a}	0.017*
Fracture energy, mJ [1]	946.59±69.64	883.95±76.35	889.67±69.62	812.50±56.23	0.589
Fracture force, N [1]	276.27±15.04	242.30±15.81	245.88±9.32	277.38±18.39	0.204
Fracture stress (rectangle), MPa [1]	84.75±4.69	97.40±6.91	109.94±8.55	93.39±6.29	0.080
Fracture stress (ellipse), MPa [1]	56.06±3.59	62.00±4.40	69.98±5.45	59.45±4.00	0.160

a, b, c, d; *Mean values within a row with no common superscript differ significantly, *** P<0.001, * P<0.05, [1] n=12, [2] n=10*

Table 7. *Effects of boric acid and ascorbic acid on liver and plasma MDA (Malondialdehit) levels (x ± Sx)*
Tablo 7. *Borik asit ve askorbik asidin karaciğer ve plazma MDA düzeyi üzerine etkileri*

Parameters	Control	Ascorbic acid	Boric acid	Ascorbic acid + Boric acid	P
Liver, µg/g	0.59±0.03^{a}	0.43±0.02^{c}	0.65±0.02^{a}	0.51±0.02^{b}	0.000***
Plasma, µg/ml	0.23±0.02^{a}	0.10±0.01^{c}	0.18±0.02^{b}	0.11±0.01^{c}	0.000***

a, b, c; *Mean values within a row with no common superscript differ significantly, *** P<0.001, n=12*

Table 8. *Effect of boric acid and ascorbic acid on liver and thigh muscle boron concentration (x ± Sx)*
Tablo 8. *Borik asit ve askorbik asidin karaciğer ve but kası bor konsantrasyonu üzerine etkisi*

Parameters	Control	Ascorbic acid	Boric acid	Ascorbic acid + Boric acid	P
Liver, ppm	0.27±0.10^{bc}	0.17±0.08^{c}	0.92±0.17^{a}	0.70±0.23^{ab}	0.004**
Thigh muscle, ppm	2.44±0.05^{c}	1.93±0.09^{d}	4.53±0.10^{a}	3.14±0.27^{b}	0.000***

a, b, c, d; *Mean values within a row with no common superscript differ significantly, *** P<0.001, ** P<0.01, n=12*

were statistically significant differences between control and the treatment groups for liver and plasma MDA level *(Table 7)* and liver and thigh muscle boron content *(Table 8)*. Plasma MDA concentration decreased in all experimental groups compared with the control group (P<0.001), but liver MDA concentration increased only with boric acid supplementation group. Dietary boric acid supplementation increased boron concentration in liver (P<0.01) and also thigh muscle (P<0.001) compared with other groups.

DISCUSSION

In the present study, supplementation of boric acid and ascorbic acid resulted in a significant increase in body weight, body weight gain, and feed efficiency during the first 21 days of the experimental period as well as hot carcass yield in broilers. Fassani et al.[21] reported that the addition of boron (30, 60, 90, 120 and 150 ppm) and also the study [6] which was evaluated addition of 5 ppm boron resulted with increasing body weight and body weight gain in 0-21 days. Yıldız et al.[22] suggested that boron addition to diets had no negative effects about performance in 42 days and also did not affect the carcass weight. Sahin et al.[11] found that supplemental ascorbic acid (250 ppm) increased carcass yield in broilers. On the contrary, Sahin et al.[12] observed that ascorbic acid addition significantly decreased the carcass weight and yield in quails, because they studied reared under heat stress conditions.

Results of the present study about serum parameters (total protein, cholesterol, triglyceride and ALT) are in agreement with findings of severel researchers [22,24-26]. Kurtoglu et al.[27] reported that supplemental boric acid did not significantly affect the serum cholesterol concentration in broilers. Eklin et al.[28] have also shown that the addition of boron did not have any affect of cholesterol levels of animals in their trial. On the other hand Eren et al.[29] reported that the amount of serum cholesterol levels of quails decreased as the levels of B (10, 60, 120, 240 mg/kg) increased. Eren and Uyanik [30] also pointed out for laying hen's cholesterol levels were decreased by increasing levels of B (0, 5, 10, 50, 100, 200 or 400 mg/kg) addition to diets. Ascorbic acid supplementation of the present study, in terms of serum parameters data, achieved in results similar to those of boric acid. Gursu et al.[31] stated that dietary ascorbic acid did not change the serum cholosterol, trigyliceride concentration and ALT activity. Similarly, Erdogan et al.[32] reported that these parameters were not affected by ascorbic acid supplementation but AST and ALT activities were increased by addition of ascorbic acid.

In the present experiment, tibia P and boron contents increased whereas vertical diameter unit decreased with both dietary boric acid and ascorbic acid supplementation. Similar to results of the present study, Mizrak et al.[24] found that boric acid supplementation (30 ppm) increased bone P content. Mizrak et al.[33] have also reported that dietary supplementation of boric acid (5 and 25 ppm) increased bone P level. Results of the present study are in agreement with findings of severel researchers [34,35], with respect to dietary boric acid supplementation for bone boron content of poultry. In the present study, boric acid and ascorbic acid supplementation resulted in any effect for bone crude ash, Ca level and some parameters (weight, length, robustness index, fracture energy, force and stress). These findings showed positive correlation with a study [36] which evaluated addition of B (60, 120, 180, 240 and 300 ppm) to broiler diets. Konca et al.[37] have also shown that ascorbic acid supplementation did not change these bone parameters.

Surprisingly, in the present study, supplementation of boric acid decreased plasma MDA concentration similar to ascorbic acid. On the basis of research literature, it could be said that this is the first study to evaluate the effect of boric acid supplementation on plasma concentration of MDA. But there are a lot of study [11,23,38-41] which were investigated the effects of ascorbic acid supplementation to the diets on MDA level. They found that ascorbic acid decreased MDA concentration as an indicator of lipid peroxidation. In this study, the presence of boric acid in the diet resulted in increases of liver and thigh muscle boron concentrations. These findings are in agreement with findings of severel researchers [34,42,43].

The result of the current study indicate that boric acid and ascorbic acid, as dietary supplements improved body weight, body weight gain, feed efficiency and hot carcass yield. Tibia P and tibia, liver and thigh muscle boron content increased with addition of boric acid. However plasma MDA concentrations were decreased. In coclusion, the findings of the current study offer that boric acid and ascorbic acid indicated that the positive effects on performance, blood and bone parameters.

REFERENCES

1. Yildiz G, Ozcelik F, Koksal BH, Bagder S, Abacioglu O: Organik bor üretilebilirliği ve broyler rasyonlarinda bor ile humatin kullanimi. *2. Ulusal Bor Çalıştayı, 17-18 Nisan,* Ankara, Bildirileri Kitabı, s.597-604, 2008.

2. Cox C: Boric acids and borates. *J Pes Ref*, 2, 10-15, 2004.

3. Schauss AG: Boron. http://www.Traceminerals.com/products, *Accessed:* 17.04. 2005.

4. Naghii MR: The significance of dietary boron with particular reference to athletes. *Nutr and Health*, 13, 31-37, 1999.

5. Elliot MA, Edwards HM JR: Studies to determine whether an interaction exist among boron, calcium, and cholecalciferol on the skeletal development of broiler chickens. *Poultry Sci*, 71 (4): 677-90, 1992.

6. Rossi AF, Miles RD, Damron BL, Flunker LK: Effects of dietary boron supplementation on broilers. *Poult Sci*, 72, 2124-2130, 1993.

7. Murray FJ: A human health assessment of boron. *Biol Trace Elem Res*, 66, 331-341, 1998.

8. Cemeroglu B: Meyve ve Sebze İşleme Teknolojisi. 1. Cilt, 2. Baskı, Gıda Tekn. Der. Yayınları, 35, Ankara, s.55-60, 2004.

9. Yarsan E, Gulec M: Kanatlılarda stres, vitamin ve mineral uygulamaları. *Türk Vet Hekim Birlik Derg*, 3 (3-4): 55-63, 2003.

10. Zook EG: Total boron. *J Assoc Agric Chem*, 48, 850, 1965.

11. Sahin K, Sahin N, Kucuk O: Effects of chromium, and ascorbic acid supplementation on growth, carcass traits, serum metabolites, and antioxidant status of broiler chickens reared at a high ambient temperature (32°C). *Nut Res*, 23 (2): 225-238, 2003.

12. Erdogan Z, Erdogan S, Aksu T, Baytok E: The effects of dietary lead exposure and ascorbic acid on performance, lipid peroxidation status and biochemical parameters of broilers. *Turk J Vet Anim Sci,* 29, 1053-1059, 2005.

13. AOAC: Official Methods of Analysis of the Association of Official

Analytical Chemists. 14th ed., Virginia, USA, 1990.

14. Türk Standartları Enstitüsü: Hayvan Yemleri - Metabolik (Çevrilebilir) Enerji Tayini (Kimyasal Metod). TSE No: 9610. TSE, Ankara, 1991.

15. Vanatta LE, Coleman DE, Slingsby RW: Low-level calibration study for a new ion chromatographic column to determine borate in deionized water. *J Chromatogr A*, 850, 107-117, 1999.

16. Karatepe M: Simultaneous determination of ascorbic acid and free molandialdehyde in human serum by HPLC-UV. *LG CG Asia Pac,* 22 (4): 362-365, 2004.

17. AOAC: Methods of Analysis of the Association of Official Analytical Chemists. 14th ed., Washington, DC, 1994.

18. Patterson PH, Cook ME, Crenshaw TD, Sunde ML: The bio-phosphonate alendronate (MK-217) inhibits bone loss due to overiectomy in rats. *J Bone Miner*, 6, 339-346, 1986.

19. Duncan DB: Multiple range and multiple F tests. *Biometrics*, 11, 1-42, 1995.

20. Sumbuloglu K, Sumbuloglu V: Biyoistatistik. 6. Baskı. Özdemir Yayıncılık, Ankara, 1995.

21. Fassani EJ, Bertechini AG, Brito JAG, Kato RK, Fialho ET, Geraldo A: Boron supplementation in broiler diets. *Braz J Poult Sci*, 6 (6): 213-217, 2004.

22. Yildiz G, Koksal BH, Abacioglu O: Rasyonlara ilave edilen maya ve borik asitin broylerlerde performans, karkas ve bazi kan parametreleri üzerine etkisi. *Kafkas Univ Vet Fak Derg*, 17 (3): 429-434, 2011.

23. Sahin K, Onderci M, Sahin N, Gursu MF, Kucuk O: Dietary vitamin C and folic acid supplementation ameliorates the detrimental effects of heat stres in Japenese quail. *J Nutr*, 133(6): 1882-1886, 2003.

24. Mizrak C, Bozkurt M, Kucukyılmaz K, Catli AU, Cinar M, Cabuk M, Bintas E: Etlik piliç karma yemlerine farkli düzeylerde bor ilavesinin performans, kemik gelişimi ile kalsiyum metabolizmasi üzerine etkilerinin belirlenmesi. BOREN-2006-46-G12-12 Kodlu Proje Raporu, 2007.

25. Koksal BH, Yildiz G, Sizmaz O: Effects of boric acid and humate supplementation on some performance and egg quality parameters of laying hens. *Braz J Poultry Sci,*14 (4): 283-289, 2012.

26. Mizrak C, Ceylan N: Damızlık yumurta tavuğu yemlerine farklı seviye ve formda bor ilavesinin performans, kemik gelişimi ve bazı kan parametreleri üzerine etkisi. *V. Ulusal Hayvan Besleme Kongresi,* 30 Eylül-03 Ekim, Tekirdağ/Çorlu, Tam Metinler Kitabı, s.130-138, 2009.

27. Kurtoglu F, Kurtoglu V, Celik-Kececi T, Nizamlioglu M: Effects of dietary boron supplementation on some biochemical parameters, peripheral blood lymphocyte, splenic plasma cell counts and bone characteristics of broiler chicks fed with adequate or inadequate vitamin D3 containing diet. *Br Poultry Sci*, 46 (1): 87-96, 2005.

28. Eklin RG, Freed M, Watkins BA, Srebnik M, Kieft KA, Newton RS: Evaluation of two novel biochemicals on plasma and egg yolk lipid composition and laying hen performance. *Poult Sci*, 72, 513-520, 1993.

29. Eren M, Kocaoglu Guclu B, Uyanik F, Karabulut N: The effects of dietary boron supplementation on performance, carcass composition and serum lipids in Japanese quails. *JAVA*, 5 (12):1105-1108, 2006.

30. Eren M, Uyanik F: Influence of dietary boron supplementation on some serum metabolites and egg-yolk cholesterol in laying hens. *Acta vet Hung*, 55 (1): 29-39, 2007.

31. Gursu MF, Onderci M, Gulcu F, Sahin K: Effects of vitamin C and folic acid supplementation on serum paraxonase activity and metabolites induced by heat stress *in vivo. Nutr Res*, 24, 157-164, 2004.

32. Erdogan Z, Erdogan S, Celik S, Unlu A: Effects of ascorbic acid on cadmium-induced oxidative stress and performance of broilers. *Biol Tr Elem Res*, Abstr., 104 (1): 19-32, 2005.

33. Mizrak C, Yenice E, Can M, Yildirim U, Atik Z: Effects of dietary boron on performance, egg production, egg quality and some bone parameters in laying hens, South African. *J Anim Sci,* 40 (3): 257-261, 2010.

34. Wilson JH, Ruszler PL: Long term effcts of boron on layer bone strength and production parameters. *Br Poult Sci,* 39 (Abstract), 1998.

35. Dogan V, Bahiiyarca Y: Japon bıldırcınlarında inorganik bor kaynaklarının nispi biyolojik kullanilabilirliği konusunda bir araştırma. *2. Ulusal Bor Çalıştayı*, 17-18 Nisan, Ankara, Bildiriler Kitabı, s.619-625, 2008.

36. Kurtoglu V, Kurtoglu F, Coskun B: Effects of boron supplementation of adequate and inadequate vitamin D3-containing diet on performance and serum biochemical characters of broiler chickens. *Res Vet Sci*, 71, 183-187, 2001.

37. Konca Y, Kirkpinar F, Yaylak E, Mert S: Effect of dietary ascorbic acid on performance, carcass composition and bone characteristics of turkeys during high summer temperature. *AJAS*, 21 (3): (Abstr.), 2008.

38. Sahin K, Sahin N, Yaralioglu S: Effects of vitamin C and vitamin E on lipid peroxidation, blood serum metobolites and mineral concentrations of laying hens reared at high ambient temperature. *Biol Tr Elem Res,* 85, 35-45, 2002.

39. Sahin K, Onderci M, Sahin N, Gursu MF, Gursu MF: Ascorbic acid and melatonine reduce heat-induced performance inhibition and oxidative stres in Japanese quails. *Br Poult Sci,* 45 (1): 116-122, 2004.

40. Karabulut-Bulan O, Bolkent S, Yanardag R, Bilgin-Sokmen B: The role of vitamin C, vitamin E and selenium on cadmium-induced renal toxicity of rats. *Drug Chem Toxicol*, 31, 413-426, 2008.

41. Seven İ, Tatlı-Seven P, Yılmaz S: Responses of broilers under cold conditioning (15ºC) to dietary triiodothyronine and iodine combined to antioxidants (selenium and vitamin C). *Kafkas Univ Vet Fak Derg*, 15 (4): 499-504, 2009.

42. Rossi AF: Effect of boron supplementation of practical corn, soybean meal diets for poultry. PhD Dissertation, University of Florida, 1990.

43. Ozkurt S: Çatören ve Kunduzlar (Kırka - Eskişehir) baraj göletlerindeki sazanların (*Cyprinus carpio* L., 1758) dokularinda bor birikimi. *Türk J Biol*, 23, 663-676, 2000.