

## Effect of Boron on broiler productive traits and immune response of Newcastle disease vaccine

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### Abstract

This study was performed to investigate changes in growth performance, blood pictures, weights of internal organs and immune response to Newcastle disease vaccine (ND vaccine) of broilers fed different levels of Boron (75,150 and 250mg/kg) in feed from 5 weeks. 120 broiler chicks (one day old) were randomly divided into four equal groups (each group contain 30), as following: first group (G1) was received 75 mg/kg of Boron, second group (G2) was received 150 mg/ kg of Boron, third group (G3) was received 250 mg/ kg of Boron and fourth group (G4) was not received Boron in feed and consider as control, All groups were vaccinated with ND vaccine at 10 and 20 days old, Growth performance of the chicks (Body weight, weight gain and mortality rate) were weekly determined, at the end of experiment weights of internal organs (liver, kidney and bursa of fabricius) were determined and Blood samples were collected to measured Ab titer against ND vaccine by ELISA test and to determined blood pictures (RBCs, PCV, HB), The results of this study showed that body weight, weight gain, blood pictures and Ab titers were highly significant increase ( $p<0.01$ ) in G2 as compared to control group followed by G3 and G1 respectively in all weeks. The mortality rate was significantly decrease ( $p<0.01$ ) in G1, G2 and G3. Whereas the weights of internal organs (liver, kidney and bursa of fabricius) were significantly increase in G3, G2 and G1 respectively. In conclusion, the results indicated that all levels of Boron supplemented diet of broiler chicken caused improvement of growth performance, blood parameters, and without inhibition of the immunity response of chicken against Newcastle disease vaccine.

Keywords: Boron, broiler, growth performance, blood cells, immune response

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دراسة تأثير عنصر البورون على الصفات الإنتاجية للدجاج اللحم والاستجابة المناعية للقاح

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### الخلاصة

أجريت الدراسة لبحث التغيرات في أداء النمو، الصورة الدموية، أوزان الأعضاء الداخلية والاستجابة المناعية للقاح نيوكاسل في أفراخ دجاج لاحم أعطيت تراكيز مختلفة من عنصر البورون (75، 150 وملغم لكل كغم) عن طريق العلف ومن عمر يوم واحد ولغاية انتهاء التجربة، تم استخدام 120 فرخة دجاج ويعمر يوم واحد وقسمت عشوائياً إلى أربعة مجاميع متساوية وكالاتي المجموعة الأولى أعطيت 75 ملغم لكل كغم، المجموعة الثانية أعطيت 150 ملغم لكل كغم، المجموعة الثالثة أعطيت 250 ملغم لكل كغم والمجموعة الرابعة لم تعطى بورون

بالعلف واعتبرت مجموعة سيطرة تم قياس الصفات الإنتاجية للأفراخ (وزن الجسم، الزيادة الوزنية) ونسبة الهلاكات وكذلك تم إجراء الفحوصات لبعض الصفات الدمية (حساب العدد الكلي لخلايا الدم البيض WBC، خلايا الدم الحمر RBC، الهيموغلوبين Hb وحجم خلايا الدم المرصوص PCV) وأيضاً تم قياس أوزان بعض الأعضاء الداخلية (الكبد والكلية وجراب فابريشيا) وكذلك قياس معيار الأضداد المناعية للقاح مرض نيوكاسل بواسطة اختبار الاليزا، أظهرت نتائج الصفات الإنتاجية والصفات الدمية والاستجابة المناعية معيار الأضداد المناعية تفوق مجموعة G2 معنوياً عن باقي المجموع تليها مجموعة G3 ومجموعة G1 مقارنة بمجموعة السيطرة G4 وفي جميع الأسابيع أما نسبة الهلاكات الطبيعية فقد شهدت انخفاضاً معنوياً في مجموعة G2 ومجموعة G1 ومجموعة G3 في الأسبوع الثالث والرابع أما أوزان الأعضاء الداخلية (الكبد والكلية وجراب فابريشيا) فقد شهدت زيادة معنوية في كل من المجموعة G3 والمجموعة G2 والمجموعة G1 على التوالي، نستنتج من ذلك ان كل التراكيز المستخدمة والمضافة لعلف الأفراخ في هذه الدراسة كان ذا تأثير إيجابي على الأداء الإنتاجي، الاستجابة المناعية والصفات الدمية.

### Introduction

Boron is the fifth element in the periodic table, it's the only non metal in the group IIA elements, but contain characters between those of metal and non metal(1). Boron is ubiquitous in nature and its commonly found in soils, rocks and surface of ocean water in the form of boric acid and inorganic borates(2). In nature B is found either bound to oxygen or in the borate form, organic compound containing Boron bound to oxygen or nitrogen groups are referred to as organoboron compounds these complex found in plant, animal and human tissue (3). Since boron has not been consistently accepted as an essential element for higher animals and plants, its importance in poultry nutrition has been recognized only since the late 1980s were some functions and relation ships of boron were suggested by Hunt and Nielsen (4) including improvement of the growth rate, nutritional efficiency, calcium and phosphorus retention in broilers besides reduction of vit. D deficiency symptoms (5). Boron play an important role in the metabolism of cro-minerals in broilers, mainly calcium, improving the balance of the mineral and bone fractures mainly in processing plants (6) Although boron is not considered essential for poultry or most animals the inclusion of 2 ppm in poultry feed was recommended by NRC (7) such suggestions are not present in the requirements for poultry in 1994(8). Boron may be toxic in high doses, addition of 400 mg/L boron in drinking water has been shown to inhibit the development of intestinal villi in Gushi chickens(9). Also high doses of boron can cause damage of reproductive and digestive organs, and high doses of boron (>200mg/l) could significantly inhibit the growth of immune organs and even exhibit toxic effect but appropriate supplements of boron (<100mg/l) could improve the growth of immune organs in broiler after 4 weeks (10). thus, the purpose of this study was to investigate the effect of different levels of Boron on growth performance, blood pictures, weight of internal organs and immune response of broiler to Newcastle disease vaccine.

### Materials and Methods

- **Broilers Chicks:** The experiment was done at the Poultry house at the department of Veterinary Public Health, College of Veterinary Medicine-Baghdad University, after cleaning and disinfecting, Feeders and water utensils were cleaned and disinfected, newly hatched chicks of the Ross breed, were brought in good condition from Al-Gamieea Hatchery-Baghdad-Abu-Ghraib. Chicks were vaccinated with NDV vaccine Lasota strain (Intervet-Germany) by manual oral drench at 10 days old, and 20 days. The basal diet was formulated for chicks according to National Research Council. Table (1) shows the ingredients and calculated chemical analysis of this diet, Boron was weighted individually and supplemented to diet in homogenous form.

**Table (1) Ingredients of feed used in this study**

Constituents	Percentages (%) of ingredients in D1
Wheat	34.2
Yellow corn	35
Soybean meal(45%protein )	20
Animal Protein (40% protein) (Meat and bone meal)	10
Calcium (CaCo3)	0.7
Salt (NaCl )	0.1
Total	100%

- **Design of experiment:** Boron powder was at the level (75,150, 250 mg/kg. feed) was tested at first day to the end experimental period (35 days). A total of 120 chicks at age of one day old were divided randomly into four groups each group have 30 chicks as follow:
  - Group 1: broiler fed boron (75 mg /kg. feed)
  - Group 2: broiler fed boron (150 mg/kg. feed)
  - Group 3: broiler fed boron (250 mg/kg. feed)
  - Group 4: Control chicks fed the basal diet no boron
- **Parameters included in this study:**
  - **Live body weight:** The weights of each group of chicks separately were taken at weekly intervals by weighting chicks individually at the end of every week and the total weights of all chicks were divided by the number to find the average weight of the chicks in gram (11).
  - **Weekly body weight gain:** The weight gains were calculated depending on the difference in body weight between the beginning of the week and the end of it, depending on the following equation:  
 Weekly body weight gain = Body weight at the end of the week - body weight at the beginning of the week (11).
  - **Estimation of relative weights of liver, kidney, bursa weight to the total body weight (relative weight):** At the end of each experiment 15 birds were chosen from each group randomly and there live weight was taken then slaughtered, and samples from the liver, kidney, bursa were collected after slaughtered the chicks. Carcass chicks were cleaned and weighted. The relative weight of each organ was measured according to the following equation:  

$$\text{Relative weight of the organ (\%)} = \frac{\text{Weight of organ}}{\text{Weight of live bird}} \times 100(12)$$
- **Blood sampling for Hematological tests:** Blood samples were randomly collected at the end of the experiment from (20) chicks from each group. The procedure of blood collection was carried out by slaughter of chicks followed and blood samples were taken to determine antibody titers against ND in blood serum by using ELISA test (Synobiotics-USA), Total red blood cells counting (cell/ mm<sup>3</sup>), Total White Blood cells counting (cell/mm<sup>3</sup>), Packed cell volume PCV% were measured by hemocytometer method described by (13), also measured of Hemoglobin concentration (g/dl)(14).
- **Statistical Analysis:** The statistical Analysis System-SAS(15) program was used to detect differences best different groups. least significant difference-LSD test was used to significant compare between means in this study.

## Results

The effects of boron supplemented in feed on the Body Weight (BW) and Weight Gain (WG) of broilers are shown in Table (1) and in Table (2). The addition of boron (75, 150, 250 mg/kg) to the diets caused a significant increased ( $p < 0.01$ ) in BW compared to the control group for all weeks. The BW G2 was higher than that of

chicken in G1 and G3 in all weeks except 4<sup>th</sup> week showed significant differences, Also there was a significant differences ( $p<0.01$ ) between G3 and G1 in 3<sup>rd</sup> and 5<sup>th</sup> week. The results of GW are presented in table (2) which revealed a significant increased ( $p<0.01$ ) in G2 compared to control group for all weeks, also G1 exhibited a significant increased ( $p<0.01$ ) in GW in comparison to control group for all weeks, except 3<sup>rd</sup> week, while G3 showed significant increased ( $p<0.01$ ) relative to control group except 2<sup>nd</sup> and 4<sup>th</sup> week. Mortality rate of chicken are shown in Table (3), the results revealed significant differences between all groups in 1<sup>st</sup> and 2<sup>nd</sup> weeks, while in 3<sup>rd</sup> and 4<sup>th</sup> weeks there was a significant decreased ( $p<0.05$ ) of mortality rate in groups supplemented with boric acid compared with control group, also in 5<sup>th</sup> week there was in significant decreased in G2 and there was no mortality rate in G1 and G3 compared with the control group. The results of blood parameters are summarized in Table (4), G2 showed a significant increased ( $p<0.01$ ) in PCV%, RBCs and WBCs count and HB concentration followed by G1 and G3 respectively, compared to control group Also, G1 revealed a significant increase in PCV%, WBCs and RBCs number and HB concentration compared with control group. While G3 showed a significant increase ( $p<0.01$ ) in PCV%, RBCs, WBCs count and HB concentration in comparison to control group and other groups. The effect of boron supplementation in diet on the weight of internal organs are shown in table (5) the weight of liver, kidney and bursa of fabricious are significantly increased ( $p<0.01$ ) in G3 and G2 compared with control and G1. while G1 showed a significant increased ( $p<0.01$ ) in weight of kidney and bursa of fabricious and in significant increased in weight of liver compared with control group. The effect of B supplementation on immune response of chicken against Newcastle disease vaccine (ND) vaccine are presented in table (6). The results revealed a significant increased ( $p<0.01$ ) in Ab titers of G1, G2 and G3 as compared with control group, also there was a significant differences ( $p<0.01$ ) in G1 compared with G2 and G3, the best immune response was seen in G1 followed by G2 and G3 respectively.

**Table (1) Effect of boron supplemented in feed on body weight (g) of broilers (Mean±SE)**

Group	Mean ± SE (gm)				
	1 <sup>st</sup> week	2 <sup>nd</sup> week	3 <sup>rd</sup> week	4 <sup>th</sup> week	5 <sup>th</sup> week
G1	154.80±5.52 b	386.40±12.55 b	728.60±9.47 c	1197.10±74.25 a	1651.60±13.3 c
G2	147.80±2.63 a	426.00±5.53 a	812.50±3.86 a	1204.60±13.54 a	2083.40±13.38 a
G3	157.50±3.64 b	334.40±8.01 c	771.50±5.61 b	1157.50±24.12 a	1957.20±32.90 b
G4	142.00±4.38 c	312.80±2.95 d	639.10±1.97 b	982.40±3.41 b	1392.90±2.71 d

Small litters means significant differences ( $p<0.01$ ) between groups

**Table (2) Effect of boron supplemented in feed on gain weight (g) of broilers (Mean±SE).**

Group	Mean ± SE (gm)				
	1 <sup>st</sup> week	2 <sup>nd</sup> week	3 <sup>rd</sup> week	4 <sup>th</sup> week	5 <sup>th</sup> week
1	109.80±5.52 b	231.60±13.35 a	342.20±75.36 c	468.50±75.36 a	454.50±78.26 b
2	130.80±2.63 a	251.20±4.29 a	386.50±6.70 b	392.10±6.70 a	878.80±31.70 a
3	115.50±3.64 b	176.90±8.47 b	437.10±12.77 c	386.00±23.72 ab	799.70±39.93 a
4	101.00±4.38 c	170.80±6.11 c	326.30±4.57 c	343.30±2.31 b	410.50±4.81 bc

Large litters means significant differences ( $p<0.01$ ) between groups and small litters means significant differences ( $p<0.05$ ) between groups.

**Table (3) Effect of boron supplemented in feed on Mortality percentage% of broilers**

Group	Mortality percentage%				
	1 <sup>st</sup> week	2 <sup>nd</sup> week	3 <sup>rd</sup> week	4 <sup>th</sup> week	5 <sup>th</sup> week
G1	0.00	0.00	3.33	3.33	0.00
G2	3.33	0.00	0.00	3.33	3.33
G3	0.00	0.00	6.66	0.00	0.00
G4	0.00	0.00	9.99	6.66	3.33
Level of significant	NS	NS	*	*	NS

\*(P&lt;0.05).

**Table (4) Effect of boron supplemented in feed on blood parameters of broilers**

Group	Mean $\pm$ Se			
	(%) PCV	RBCs $\times 10^6$	WBCs $\times 10^3$	Hb(g/dl)
G1	29.88 $\pm$ 0.38 b	2.40 $\pm$ 0.01 c	19.74 $\pm$ 0.08 C	10.84 $\pm$ 0.03 c
G2	36.23 $\pm$ 0.17 a	3.59 $\pm$ 0.02 a	23.14 $\pm$ 0.15 A	13.50 $\pm$ 0.01 a
G3	28.94 $\pm$ 0.26 c	2.61 $\pm$ 0.03 b	20.87 $\pm$ 0.02 B	11.74 $\pm$ 0.04 b
G4	28.99 $\pm$ 0.14 c	2.36 $\pm$ 0.01 c	18.18 $\pm$ 0.12 D	9.15 $\pm$ 0.02 d

Small litters means significant differences (p&lt;0.01) between groups

**Table (5) Effect of boron supplemented in feed on relative weight (gm) of organs**

Group	Mean $\pm$ Se (gm)		
	Relative weight of liver	Relative weight of Kidney	Relative weight of bursa of fabricius
G1	3.22 $\pm$ 0.04 c	0.855 $\pm$ 0.01 c	1.13 $\pm$ 0.01 c
G2	3.65 $\pm$ 0.02 b	0.956 $\pm$ 0.01 b	1.25 $\pm$ 0.001 b
G3	3.73 $\pm$ 0.02 a	1.08 $\pm$ 0.01 a	1.52 $\pm$ 0.02 a
G4	3.05 $\pm$ 0.05 c	0.760 $\pm$ 0.013 d	0.877 $\pm$ 0.02 d

Small litters means significant differences (p&lt;0.01) between groups

**Table (6) Effect of boron supplemented in feed on antibody titers against ND vaccine in broilers (M $\pm$ SE).**

Groups	Mean $\pm$ SE
	ND titer
G1	3553.40 $\pm$ 13.80 b
G2	4153.80 $\pm$ 8.81 a
G3	3393.20 $\pm$ 3.46 c
G4	3111.50 $\pm$ 2.86 d

Small litters means significant differences (p&lt;0.01) between groups

## Discussion

In the present study, the results showed that three levels of boron (i.e. 75,150 and 250 mg/kg) induced improvement of the growth by significantly increase of BW and WG especially the addition of 150 mg/kg, followed by 75 and 250mg/kg. These results are in agreement with other reports that found that boron supplementation had positive effect on growth performance (16) who pointed out that 5 and 25 mg/kg B added to

diets containing an adequate vitamin D<sub>3</sub> caused a significant increase in body weight on days 14 and 28 compared to the inadequate D<sub>3</sub> diet which is not supplemented with boron, in the same way, the same researcher have not observed any effect on growth in laying hens supplemented with boron (50 to 200mg/kg) for 120 days (17) Eliot and Edwards (18) stated that the body weight gains were not affected in broilers fed with boron diets containing 0, 20, 40, and 80 mg/kg. By contrast, (19) reported that the body weight significantly increased in broilers fed diet supplemented with 37.4 mg/kg for the first 21 days of experiment as well as, in birds supplemented with 57 mg/kg boron during the whole experimental period. While (10) showed that body weight and weight gain significantly reduced by addition of 200 and 400 mg/kg. The discrepancies observed among the different studies could be related to the use of various boron sources or may be due to environmental experimental conditions. The positive effect of boron on body weight and weight gain may be attributed to the role of boron on certain metabolic processes of enzymes, minerals of chickens (20), boron supplementation tended to increased bone ash and that there was a significant interaction between B and vitamin D bodyweight gain(21). The result of effect of boron supplementation on blood pictures showed that there was a positive effect on all parameters, it seems that also could affected blood cell counts and composition because blood cell formation and maturation are influenced by changes in cell membrane or kidney function or in calcium metabolism (20). However, there were only limited data on blood cell variables affected by boron supplementation in chicks or other animal spp, boron increase the response of cell membrane of blood cell to erythropoietin and this hormone synthesized in the kidney which plays a role in the maturation of red blood cell precursors in bone marrow (22) for the mortality rate the addition of boron caused significant decreased of mortality percentage of chicken, this result are in line with previous study (23, 24) this can be attributed to the doses used in this study, as 75,150 and 250 mg/kg were tolerated by the broilers because of boron is absorbed rapidly and virtually completely from gastrointestinal tract and rapidly excreted (23), the weight of internal organs (liver and kidney) influenced by boron supplementation and there was significant effect in the weight of them and this result are in agreement with (25) who found that boron supplementation at 10 and 20 ppm determined a significant effect on the liver weight, also the weight of bursa and fabricius have positive effect by boron supplementation and this result are in agreement with (10), The improvement of growth performance that caused by addition of B in diet of chicken reflexed on the health status of the chicken which enhance immune response of Newcastle vaccine, the significant increased of Ab titers in the present study perhaps attributed that the addition of boron could obviously improve the cellular and humeral immune response and immune function by enhance Fc receptor, expression and interleukin-6 production of cytokines by increasing the y production of tumor necrosis factor and interferon- $\gamma$  after a stress or disease challenge (26), This result are in agreement with (10) who found that the supplemented with 100 mg/kg of boron by drinking could obviously promote boron thymus development of chicken also found that higher boron (exceed 200 mg/litter) has inhibition and toxicity effects on the growth and on the thymus development. In conclusion, this study have shown that supplementation of 75,150 and 250 mg/kg of B in the feed of chicken cause improvement of growth performance, blood parameters, and do not inhibition the immune response of chicken against Newcastle disease vaccine.

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