Investigations on the effect of the supplemental VETABOR, boron-enriched concentrate added to broiler diets, on breast meat fatty acids profile

R.D. CRISTE[1]*, D.V. GROSSU[1], R. SCOREI[2], C.CIURASCU[1] and M. MITRUT[2]

[1]Institute of Biology and Animal Nutrition (IBNA), 077015 Balotesti, Calea Bucuresti 1, Ilfov, Romania
[2]S.C.Natural Research SRL Craiova, A I Cuza 19, 200398, Dolj, Romania
***criste.rodica@ibna.ro**

Keywords: broilers; breast; boron; fatty acids

Summary

The investigations on the effect of VETABOR, boron-enriched concentrate, on breast meat quality were conducted on 108 Cobb 500 broilers (1-42 days). The broilers were kept in metabolic cages allowing balance studies, were assigned to 3 groups (6 replicates/group) maintained at a neutral air temperature (28^0C during the first week and 24^0C during the subsequent weeks). The basal compound feed formulation for each growth stage was similar for all groups. The experimental groups differed by the amount of supplemental VETABOR: 0.3337 g/kg broiler/day (E1) and 0.6674 g/kg broiler/day (E2). The 3 compound feed formulations were isocaloric, isoprotein and similar levels of total sulphur amino acids, lysine, available calcium and phosphorus. At the end of the experiment (42 days), 18 broilers from each group were slaughtered and samples of serum, bone and breast were collected. The serum and bone samples were assayed for Ca, P and B levels, while the breast meat sample was assayed for the fatty acids and cholesterol levels. Feed intake was registered on a daily basis and the live weight was measured on a weekly basis to determine the average weight gain and the feed conversion ratio. Excreta was recorded on a daily basis on weeks 2 and 4 in order to make the boron balance by assaying the average weekly samples. The experimental results have shown that B balance was negative in the control group (no supplemental VETABOR), which shows the necessity of supplemental B in broiler diets, while the level of linolenic acid was significantly higher in the breast muscle of E2 broilers, which received the highest dose of VETABOR.

Introduction

Boron is acknowledged as essential trace element for plants playing a role in plant growth and development. In its absence, plant growth halts and the plant makes no fruits. An increasing number of studies conducted during recent years presumed that boron could be essential in animals since its deprivation in both experimental animals and humans causes changes in biological function which are reversible by restoration of boron. The functions of boron are unknown but it might be involved in metabolism and utilisation of various elements (ex. Ca, Cu, Mg), glucose, triglycerides, reactive oxygen and oestrogen. Bakken and Hunt (2003) suppose that the dietary boron influences energy substrate metabolism in a wide variety of biological species including humans. Hunt (1994) has summarizes evidence that supports working hypotheses for the roles of boron in animal model systems. He shows that research findings suggest that physiologic amounts of supplemental dietary boron affect a wide range of metabolic parameters in the chick and rat model systems and the current interest in boron animal nutrition began with the initial finding that supplemental dietary boron stimulates growth in cholecalciferol (vitamin D3)-deficient chicks, but does not markedly affect growth in chicks receiving adequate vitamin D3 nurture. The effect of the dietary boron given to broilers on bird development and on bone mineralization was investigated by several teams (King *et al.*, 1991; Elliot *et al.*,1992; Rossi *et al.*,1993; Hunt et al1994).

The product VETABOR was supplied to Institute of Biology and Animal Nutrition, Romania for studies by the private research company SC Natural Research SA. It was originally developed and manufactured as fertiliser for fruit trees, wine yards and cereal crops. Considering its good performance (increased volumetric weight of wheat for instance) and the investigations on boron in animals, the idea came up for using it in animal feeding. The present study shows part of the data obtained from the feeding experiments on broilers.

Material and method

The experiment was conducted on 108 Cobb 500 commercial broiler hybrid throughout the age period 1-42 days. The broilers were raised in metabolic cages that allow balance studies and were assigned to 3 groups (6 replicates per group).The environmental temperature was 28^{0}C during the first week and 24^{0}C throughout the rest of time. The broilers had free access to the feed and water. All groups received the same basal compound feed consisting of corn, wheat, fish meal, full fat soybean. The dietary premix, the same for all groups, was a formulation (Zoofort A1, A2) developed by the Institute of Biology and Animal Nutrition and it did not include boron compounds. The groups were treated with different doses of VETABOR (solution) added daily to the diets in amounts calculated to supply 0.3337g/kg broiler (recommended by the manufacturer) for group E1 and 0.6674 g/kg broiler for group E2. No VETABOR was added to the diets for the control group, C.

VETABORUL, more precisely, VETABOR STANDARD is a complex of calcium, boron and fructose produced by SC NATURAL RESEARCH, Romania. It is a clear, colourless, odourless liquid with sweet taste. Table 1 shows the analytical parameters of VETABOR.

Table 1 Reference analytical parameters of *VETABOR*.

Parameter	*Value*
pH of concentrated solution	5.0-5.5
Calcium	Min. 17 g/l
Boron	Min. 6.5 g/l
Chlorides	Maximum 0.01%
Heavy metals (Fe, Cu, Mn, Zn,)	Maximum 0.0003%
Sulphates	Maximum 0.001%
Solubility	Fully water soluble
Organoleptic features	Clear, sweet liquid

The three diet formulations differentiated according to broiler age were isocalorie, isoprotein and contained equal amounts of total sulphur amino acids, lysine, available calcium and phosphorus (Table 2).

Table 2 Chemical analysis of the feeds.

	M	E1	E2
Starter (0-14 days)			
▪ Dry matter 65^{0}C –g%	90.66	90.00	90.66
▪ Dry matter 105^{0}C –g%	97.01	97.05	97.16
▪ True dry matter –g%	87.95	87.35	88.09
▪ Crude protein –g%	23.33	23.04	23.51
▪ Ether extractives –g%	6.17	6.10	6.09
▪ Crude fibre –g%	4.52	4.16	4.47
▪ Ash –g%	6.65	6.64	6.67
▪ Calcium –g%	1.10	1.19	1.20
▪ Phosphorus –g%	0.63	0.64	0.67
▪ Boron –mg%	0	10.03	19.66

	M	E1	E2
(14 – 28 days)			
▪ Dry matter 65^0C –g%	89.00	89.00	88.00
▪ Dry matter 105^0C –g%	96.52	96.53	96.68
▪ True dry matter –g%	85.90	85.91	85.08
▪ Crude protein –g%	22.15	22.76	22.95
▪ Ether extractives –g%	8.32	8.18	8.15
▪ Crude fibre –g%	4.17	4.16	4.03
▪ Ash –g%	7.50	7.60	7.63
▪ Calcium –g%	1.00	0.99	1.02
▪ Phosphorus –g%	0.67	0.67	0.65
▪ Boron –mg%	0	18.92	33.42
28 days – 42 days			
▪ Dry matter 65^0C –g%	93.00	93.00	93.00
▪ Dry matter 105^0C –g%	93.82	93.56	93.40
▪ True dry matter –g%	87.25	87.01	86.96
▪ Crude protein –g%	20.35	20.20	20.07
▪ Ether extractives –g%	8.55	8.50	8.47
▪ Crude fibre –g%	5.45	5.23	5.31
▪ Ash –g%	7.28	7.24	7.26
▪ Calcium –g%	1.12	1.20	1.21
▪ Phosphorus –g%	0.64	0.65	0.65
▪ Boron –mg%	0	20.73	35.03

Feed intake was recorded daily and the live weight was recorded weekly throughout the experimental period in order to determine broiler performance and feed conversion ratio. Ingesta and excreta were collected and recorded daily during weeks II and IV and the average weekly samples per cage were assayed chemically for the boron balance. At the end of the experiment (42 days), 18 broilers from each group were slaughtered and serum, tibia and breast samples were collected. The serum was assayed for Ca, P and B. The tibia samples were dried at 65^0C, degreased and assayed for ash, Ca, P and B. The breast samples were dried at 65^0C and assayed for fatty acids profile and cholesterol level.

The minerals were assayed with a Beckman SPECTRA-SPAN VI by plasma atomic emission spectrometry. The fatty acids and cholesterol were assayed by gas chromatography with a Carlo Erba 6000 VEGA gas chromatograph fitted with flame ionization detector. The statistical calculations were done with Microcal Origin software, with T test for comparing the data strings.

Results and discussion

Table 3 shows broiler performance cumulated throughout the experimental period. The performance of the experimental groups is similar to the performance of the control group, even better for the feed conversion ratio (kg feed/kg gain) in group E2. There was no mortality or any other health problem in any group.

Table 3 Broiler performance *(0-42days*).

	MU	C	E1	E2
Initial weight	g/ head	34.09	32.56	32.04
Final weight	g/ head	1862.47	1857.98	1898.68
Average daily intake	g/ head /day	80.95	79.54	79.61
Average daily gain	g/ head /day	43.64	43.46	44.45
Feed conversion ratio	g/g	1.82[a]	1.83[a]	1.79[b]

Results in a column with different letters, differ significantly ($p \leq 0.05$)

Table 4 shows serum levels of Ca, P and B. Serum Ca and P were similar in all groups and they range within the normal limits. Serum B, however, was significantly higher in both experimental groups. There was no significant difference between the experimental groups although E2 received twice as much VETABOR than E1.

Table 4 Serum levels of calcium, phosphorus and boron.

Group	CALCIUM mg% ml	PHOSPHORUS mg% ml	BORON mg% ml
C	12.02±0.23	7.88±0.06	0.005[b]±0.002
E 1	12.31±0.29	7.98±0.05	0.030[a]±0.001
E 2	12.32±0.26	8.01±0.11	0.033[a] ±0.003

Results in a column with different letters, differ significantly (p≤0.05)

The difference of VETABOR added to the diets of the two experimental groups is revealed by the coefficient of apparent absorption of the dietary B (Table 5), which was significantly higher in E2 compared to E1. Given the two fold difference of the amounts of VETABOR added to the two experimental groups, it is obvious that B elimination in E2 was higher. B balance was negative for the C group, which suggests the need to supply boron to broiler diets. No B was detected in the ingesta samples collected from group C, which might also be due to the limits of the equipment, although the emission method is recognized for its sensitiveness. This fact corroborated with the identification of traces in the droppings obviously resulted, by calculation, in a negative balance. There was no difference among groups in the coefficient of Ca absorption.

Table 5 Ca and B balance (Average values/group/broiler/day).

	CM	E1	E2
Ingested calcium (g)	1.23±0.03	1.14±0.07	1.24±0.03
Ingested boron (mg)	0[*]	19.42±0.18	35.19±0.71
Excreted calcium (g)	0.2115±0.01	0.204±0.02	0.2165±0.018
Excreted boron (mg)	0.0038±0.0006	5.090±0.011	6.185±0.083
Coefficient of absorbed calcium (%)	82.80±0.95	82.10±1.45	82.54±1.65
Coefficient of absorbed boron (%)	Negative balance	73.78±2.01[a]	82.42±2.33[b]

Results in a row with different letters, differ significantly (p≤0.05)

Table 6 shows the data of tibia chemical analysis, revealing that B level was significantly higher in the experimental groups. Bone Ca level was not different among groups, but ash was significantly higher in E2 than in C.

Table 6 Tibia chemical analysis (by dried and degreased sample).

TIBIA	C	E1	E2
Ash (g%)	52.60[b] ±0.17	53.40[a] ±0.61	53.80[a] ±1.29
Calcium (g%)	28.11 ±0.15	28.45 ±0.32	28.22 ±0.18
Phosphorus (g%)	14.07 ±0.07	14.23 ±0.24	13.37 ±0.33
Boron (mg%)	0.01[b] ±0.00	0.03[a] ±0.00	0.027[a] ±0.00

Results in a row with different letters, differ significantly (p≤0.05)

Table 7 shows the fatty acids profile of the breast muscle revealing a significantly higher level of linolenic acid in E1 (1.79 g % fat) and in E2 (2.48 g % fat) than in C (1.33 g % fat). An interdisciplinary team will have to study the biochemical mechanism accounting for this unexpected result considering that the fat level and source (sunflower oil) were similar for all three groups. One explanation could be that boron is superoxide scavenger. The cholesterol level from E1 breast sample was significantly lower than in the control group, but no significant difference was observed between E2 and C.

Table 7 Fatty acids profile and cholesterol level in the breast muscle.

	MU	C	E1	E2
Miristic acid	g%fat	0.56	0.65	0.47
Palmitic acid	g%fat	21.56	23.59	19.46
Palmitoleic acid	g%fat	2.39	3.71	2.53
Stearic acid	g%fat	8.21	8.15	7.56
Oleic acid	g%fat	26.97	28.56	28.65
Linoleic acid	g%fat	38.97	33.35	38.85
Linolenic acid	g%fat	1.33[c]	1.79[b]	2.48[a]
Cholesterol	mg%sample	60.80[b]	59.71[a]	60.53[a]

Results in a row with different letters, differ significantly ($p \leq 0.05$)

Conclusions

- The results show that in the control group (no VETABOR treatment) there was a negative B balance, which shows the necessity to add boron to broiler diets. The level of linolenic acid was significantly higher in the breast samples from E2, which received the highest dose of VETABOR.
- As tibia mineralization is concerned, the highest ash level was observed in the group treated with the highest boron dose (E2).

References

Bakken. N. A., Hunt, C. D. (2003) Dietary Boron Decreases Peak Pancreatic In Situ Insulin Release in Chicks and Plasma Insulin Concentrations in Rats Regardless of Vitamin D or Magnesium Status. *J. Nutr.* **133** : 3577–3583

Elliot, M. A., Edwards, H. M., Jr. (1992) Studies to determine whether an interaction exists among boron, calcium, and cholecalciferol on skeletal development of broiler chickens. *Poult. Sci*. **71**: 677–690.

Hunt, C. D., Herbel, J. L., Idso, J. P. (1994) Dietary boron modifies the effects of vitamin D3 nutrition on indices of energy substrate utilization and mineral metabolism in the chick**.** *J. Bone Miner. Res*. **9**: 171–181.

Hunt, C.D. (1994) The biochemical effects of physiologic amounts of dietary boron in animal nutritionmodels. *Environ Health Perspect.***102 Suppl 7**:35-43

King, N., Odom, T.W., Sampson, H. W., Yersin, A. G. (1991) The effect of in ovo boron supplementation on bone mineralization of the vitamin D-deficient chicken embryo. *Biol Trace Elem Res.* **31(3):**223-33

Rossi, A. F., Miles, R. D., Damron, B. L., Flunker, L. K. (1993) Effects of dietary boron supplementation on broilers. *Poult. Sci*. **72:** 2124–2130.