The Effect of Trace Elements Supplementation in Organic Diets for Light Breed Avian Youth on the Bioproductive Indices

Călin Julean, Dan Drinceanu, Lavinia Ştef*, Eliza Simiz, Simina Neo, Voichiţa Gherasim, Robert Nagy, Marian Bura

Banat´s University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timisoara, 300645-Timisşoara, Calea Aradului 119, Romania

Abstract
The aim of this study was to examine the bioproductive indices of light breed avian youth fed with different trace mineral levels in diets. The experiment was conducted on 168 light breed chickens divided into three experimental groups: G1 without mineral supplementation, G2 supplementation level were at 50% then G3 which was supplemented correspondent to the intensive growing system. During the entire experimental period, respectively 1–20 weeks, trace elements supplementation influenced significantly the body weight, in $G_{2,}$ which was 6% ($p<0.05$) higher compared to G_1, and 2.5% ($p>0.05$) compared G3. Efficiency of feed conversion (FCE) in G_2 and G_3 which was 10% ($p>0.05$) higher compared to G_1.

Keywords: mineral nutrition, organic feed, organic production

1. Introduction

Organic poultry production in the EU is regulated by Council Regulation (EC) No 834/2007 and Commission Regulation (EC) No 889/2008 [1]. These outline a number of general principles and they also detail various technical restrictions.
In developing these regulations, it was recognized that the rules for organic poultry production were still insufficiently developed and needed further work [2].
Feed ingredients should be obtained from safe sources. Monitoring of feed ingredients should include inspection and sampling and analysis for undesirable substances using risk-based protocols. Feed ingredients should meet acceptable and, if applicable, statutory standards for level of pathogens, mycotoxins, pesticides and undesirable substances that may give raise to consumers health hazards [3-5]).
It is recommended that the NRC (1994) [6], derived values for mineral and vitamin requirements be adopted without modification, to help ensure the correct skeletal growth and the avoidance of foot and leg problems. Conventional diets are usually formulated with higher levels of minerals and vitamins but this approach is not suggested for organic diets, to try and minimize nutrient levels above those required for normal growth and reproduction [7].
The information concerning mineral supplementation of the feed for biologically-bred poultry [6-8]) and is limited to recommendations for the utilization of premix formulas which include minerals [7, 9]). Avian youth represents a category of major importance, because adult poultry performances are strongly influenced by the way they develop [7, 10]. Regarding the mineral supplementation, researches are only a

* Corresponding author: Lavinia Stef, Tel. 0722351672 Fax. 0256277110, Email: lavi_stef@animalsci-tm.ro

few and usually they are focused on meat chickens and egg-laying hens [7, 11, 12].
The bibliographic information regarding the levels of mineral supplementation in poultry feed ingredients are still controversial; the mineral content of the feed ingredients representing the base of the diets which is usually ignored [7]. Mineral intake on the based feed ingredients in the organic poultry production can satisfy requirement at rate of 60-100% [13].
The aim of this study was to examine the production data of light breed chickens fed diets with different trace mineral levels in an organic poultry production with access to outdoor pasture.

2. Materials and methods

Bird and housing
A total of 168 straight run day old Brown Leghorn chickens were randomly distributed in chickens house (12x2 m) which was divided 12 pens (1x2 m) with initially 14 chickens per pen, in chicken house and 12 pastures pens (24x2 m) according with EU regulation (CE) no. 834/2007, (CE) no. 889/2008 [1]. Birds were kept on straw litter from day old to 20 weeks. The house were placed directly on a pasture and the earth floor inside was initially covered with 8 cm chopped wheat straw. There after 2 kg fresh straw per pen and week was added to the bedding. Chickens were given free access to water and feed. The inside temperature was regulated with 12 electric infrared heat lamps (150 w each) per house, evenly distributed over the pens. Except for the heat lamps, housing temperature followed outdoor temperature changes. Temperature in the chicken houses was recorded twice a day, in the morning and in the afternoon. Ventilation consisted of natural ventilation by windows along the long sides of the house. The windows were the only source of daylight and apart from natural daylight there was no artificial light in the chicken house, except for the light from heat lamps.
Chickens were kept indoors up to 3 weeks. During daytime, from 3 weeks to 20 weeks chickens had access to outdoor pasture and direct sunshine. Outdoor pastures were separated from each other with chicken wire fences.

Diets
According to data in Table 1, chickens in the three experimental groups were fed with the same concentrates compound during the three growing periods, (D_1, D_2 and D_3) using corn, wheat, soybean an sun-flower cakes, as well as field peas, ecologically approved.

Table 1. Composition of diet

Specification	D_1 1 day–6 weeks	D_2 7-12 weeks	D_3 13–20 weeks
Ingredients (%)			
Maize	32	32	36
Wheat	20	28	35
Soybean cake	20	5	5
Sunflower cake	7	7	7
Field peas	18	25	14
Calcium carbonate	1.1	1.1	1.1
Mono calcium phosphate	1.1	1.1	1.1
Sodium chloride	0.3	0.3	0.3
Trace mineral premix	0.5	0.5	0.5
Analysed nutrient contents (%)			
ME, MJ	11.97	11.47	11.54
CP	18.20	16.14	14.04
Calcium	0.97	0.96	0.95
Phosphorus total	0.61	0.60	0.58
Phosphorus available	0.37	0.36	0.35
Sodium	0.14	0.14	0.15

Vitamin can be omitted from the summer formula for birds to pasture and direct sunshine [7].
According to organic standards, the feed no contained coccidiostats EU regulation (CE) no.

834/2007, (CE) no. 889/2008 [1]. The mineral part which is the object of research is further presented. From the data of the Table 2, one can notice the total content of trace elements as well as the micro-mineral way of supplementation of the three experimental groups, respectively G_1 (Control), G_2 (MP_1) and G_3 (MP_2).

Experimental diets were analyzed for DM, CP, ash, Ca, and P using AOAC (2007) [14] methods. The concentrations of trace elements were determined using a flame atomic absorption spectrophotometer with high resolution continuum source (Model Contr AA 300, Analytik Jena, Germany).

Table 2. Trace elements content mg/kg of feed

	G_1 (Control *)			G_2 (MP_1**)			G_3 (MP_2***)		
	D_1	D_2	D_3	D_1	D_2	D_3	D_1	D_2	D_3
Fe	65.68	64.63	63.43	75.68	74.63	73.43	85.68	84.63	83.43
Mn	20.68	20.33	19.92	40.68	40.33	39.92	60.68	60.33	59.92
Zn	35.75	34.69	33.5	55.75	54.69	53.5	75.75	74.69	73.5
Cu	8.99	9.06	9.14	10.49	10.56	10.64	11.99	12.06	12.14
Co	0.14	0.12	0.10	0.265	0.245	0.225	0.39	0.37	0.35
I	0.11	0.13	0.15	0.31	0.33	0.35	0.51	0.53	0.55
Se	0.23	0.20	0.21	0.33	0.3	0.31	0.43	0.4	0.41

* Control-not supplemented trace elements in MP used only carrier
** MP1-supplemented accepted trace elements sources per kg of feed: Fe 10, Mn 20, Zn 20, Cu 1.5, Co 0.125 I 0.2 Se 0.1
*** MP2-supplemented accepted trace elements sources per kg of feed: Fe 20, Mn 40, Zn 40, Cu 3, Co 0.25 I 0.4 Se 0.2

Statistical analysis
Diet was used as the main effect and considered fixed for all parameters. To test the significance of differences, we used the ANOVA test, with the software IBM SPSS 19.

3. Results and discussion

Production data
Birds and feed were weighed to determine body weight and feed intake, and to calculate the feed efficiency ratio.

Body weight evolution (g)
Body weight evolution of the experimented chickens was determined based on an individual weighting performed every other week, and the data statistically processed can be found in Table 3 and in Figure 1. During the growing period between 1 day old to 6 weeks old, chickens in G_2 registered a body weight average of 463.60±55.44 g, significantly higher ($p<0.05$) than chickens in G_1 with no supplemented trace elements.
And the period between 7 and 12 weeks, keeps a significantly difference ($p<0.05$) between body weight average in G_2 of 1028.38±134.99 g and in G_1 of 968.17±968.17 g. Trace elements double supplementation did not significantly influence ($p>0.05$), the body weight differences between G_3 and G_1.

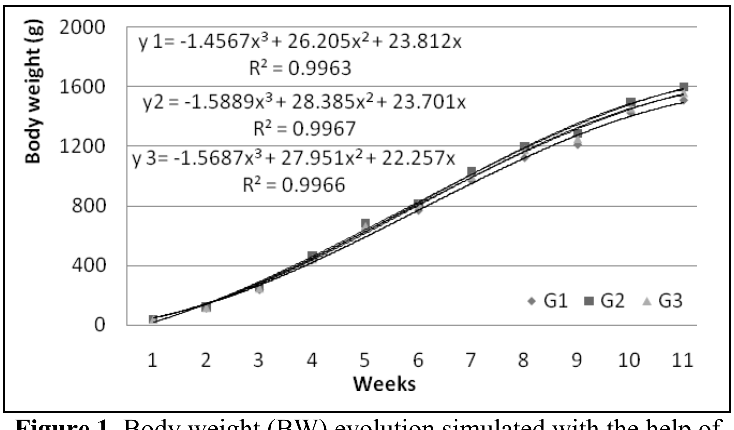

Figure 1. Body weight (BW) evolution simulated with the help of 3rd degree polynomial regression were:y-BW, x–weeks

Body weight evolution for the last growing phase (13-20 weeks) is similar to prior phases. Body weight of chickens in G_2 registers the highest growth 1598.21±174.60 g, at a significant difference ($p<0.05$) compared to variant G_1.

During the entire experimental period, respectively 1–20 weeks, trace elements supplementation significantly influenced ($p<0.05$) body weight that with an average of 1598.21±174.60 g in G_2 was 6% higher compared to index value set in G_1.

Feed intake, kg/period/chicken

Feed intake was determined every two weeks and expressed by concentrate mixture (CM) intake (kg/period/chicken) and can be seen in Table 3 and Figure 2.

Table 3. Body weight evolution, feed intake evolution chickens belonging to different experimental groups (mean±SD*)

	G_1	G_2	G_3	SEM**	p
LW, g					
Initial, hatching	38.57±2.41[a]	38.00±2.55[a]	37.70±2.31[a]	0.188	0.156
6 weeks	437.22±48.63[a]	463.60±55.44[b]	443.80±53.31[ab]	2.207	0.028*
12 weeks	968.17±107.16[a]	1028.38±134.99[b]	995.91±107.57[ab]	9.467	0.034*
20 weeks	1506.81±177.97[a]	1598.21±174.60[b]	1559.42±144.45[ab]	13.480	0.020*
Feed intake, kg/period/chicken					
6 weeks	1.066±0.071[a]	1.040±0.068[a]	1.030±0.074[a]	0.019	0.767
12 weeks	2.301±0.152[a]	2.250±0.155[a]	2.191±0.159[a]	0.042	0.623
20 weeks	3.890±0.234[a]	3.665±0.248[a]	3.835±0.274[a]	0.072	0.455
one day-20 w	7.256±0.455[a]	6.954±0.472[a]	7.056±0.509[a]	0.130	0.674
Efficiency of feed conversion (FCE) gain/feed					
0 to 6 weeks	0.37±0.026[a]	0.41±0.016[a]	0.39±0.031[a]	0.007	0.197
0 to 12 weeks	0.28±0.026[a]	0.30±0.028[a]	0.30±0.026[a]	0.007	0.445
0 to 20 weeks	0.20±0.006[a]	0.22±0.017[a]	0.22±0.014 [a]	0.004	0.100
Liveability, %	94.64	92.85	94.64		

a-a, b-b- p>0.05
a-b- p<0.05
*SD–standard deviation
**SEM-standard error of mean

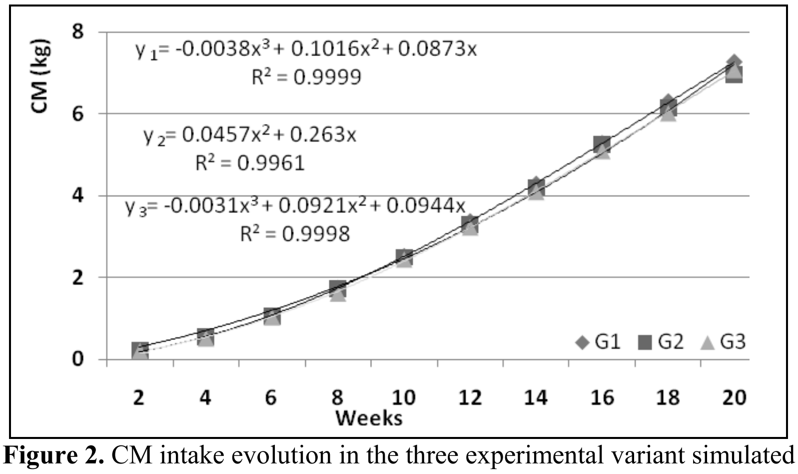

Figure 2. CM intake evolution in the three experimental variant simulated with the 3rd degree polynomial regressionwere: y-CM, x –weeks

Efficiency of feed conversion (FCE) gain kg/feed kg

Efficiency of feed conversion (FCE) gain/feed, with determinations once a fortnight is shown in Table 3.

Table values as well as the chart show that the best Efficiency of feed conversion (FCE) gain/feed registered in chickens from G_2 and G_3 for which food was supplemented with trace elements premix.

Thus, during 1 day to 6 weeks period, Efficiency of feed conversion (FCE) gain/feed for G_2 was higher by 13.88%, during 7 days to 12 weeks period, higher by 7.14%, and during the entire experimental period (1 day to 20 weeks) the index of conversion was lower by 10% compared to reference values from G_1. And the trace elements doubled dose provides a better valorization of food, thus during the entire experimental period (1 day to 20 weeks) Efficiency of feed conversion (FCE) gain/feed from G_3 is 10% higher compared to G_1.

Liveability

Mortality was low, survival rate are of 94.64% in G_1 and G_3 and of 92.85% in G_2, and they are between the limits of the organic growing system found in the professional literature [11, 15].

Trace elements total intake expressed in mg/kg gain is presented in Table 4, it visibly increases along with introducing the mineral premixes in chicken food and represents a method of evaluating their supplementary levels in avian youth of replacement, organic light breed poultry.

Table 4. Trace elements intake at the end of the experimental period (intake/kg gain)

Specification	G_1 (mean±SD*)	G_2 (mean±SD*)	G_3 (mean±SD*)	SEM**	p
Fe	323.20±11.71^a	328.71±20.96^a	389.97±25.63^b	10.548	0.002
Mn	101.59±3.68^A	179.10±13.07^B	278.85±18.32^C	22.143	0.000
Zn	172.36±6.23^A	241.77±17.64^B	343.93±22.60^C	21.701	0.000
Cu	45.82±1.67^a	47.23±3.45^a	56.06±3.68^b	1.583	0.002
Co	0.57±0.02^A	1.06±0.08^B	1.68±0.11^C	0.138	0.000
I	0.69±0.03^A	1.51±0.11^B	2.49±0.16^C	0.223	0.000
Se	1.73±0.07^A	1.38±0.10^B	1.90±0.12^A	0.070	0.000

a-a, A-A $p>0.05$
a-b $p<0.01$
A-B, A-C, B-C $p<0.001$
*SD–standard deviation
**SEM-standard error of mean

Iron intake was of 323.2, 328.71 and 389.97 mg/kg live weight gain, respectively higher up to 1.70% in G_2 and to 20.65% in G_3. For iron, there were no significant differences between G_1 and G_2 ($p>0.05$) respectively there were registered significant differences between G_1 and G_3 respectively between G_2 and G_3 ($p<0.001$).

For manganese, there were significant differences between ($p<0.001$) between experimental variants G_1 and G_2, in $p<0.001$ between G_1 and G_3, and in $p<0.001$ between G_2 and G_3.

For zinc, there were significant differences between all the experimental variants ($p<0.001$).

For copper, there were no significant differences between G_1 and G_2 ($p>0.05$) respectively significant differences ($p<0.001$) between G_1-G_3 and G_2-G_3.

Foe cobalt intake, there were significant differences ($p<0.001$) between the variant G_1 and the experimental variants G_2, and between G_1 and G_3, as well between G_2 and G_3, the differences are significant $p<0.001$.

Following the signification tests, for iodine intake there were registered significant differences ($p<0.001$) between G_1-G_2 and G_2-G_3, respectively insignificant ($p>0.05$) between G_1 and G_3.

4. Conclusions

Feed micro mineral supplementation for organic light breed avian youth allows formulating the following conclusions:

At the end of the experimental period, weight average in chickens from G_2 is higher, at a statistically provided difference ($p<0.05$) compared to chickens from G_1, and chickens weight in G_3 is higher compared to chickens from the same reference variant (G_1) at not difference statistically ($p>0.05$), that shows the feed mineral supplementation influence on this productive index.

Mineral premix (MP_1) with doses lowered by 50% in trace elements reduces feed intake as well as mineral premix MP_2 considered with full trace elements doses reduces concentrates compound intake compared to the control variant (G_1), and the differences are insignificant between the experimental variants ($p>0.05$).

A 20 weeks' experimental variant in avian youth of light breed replacement levels FCE gain/feed values in G_2 and G_3.

Trace elements intake mg/kg gain per live weight increases in cobalt, iodine, and selenium in G_2 statistically provided values ($p<0.001$), values that also impose mineral balance studies.

The recommended supplementation values of the main trace elements by a specific mineral premix for organic light breed avian youth are: 10 ppm Fe, 20 ppm Mn, 20 ppm Zn, 1,5 ppm Cu, 0.125 ppm Co, 0.2 ppm I and 0.1 ppm Se.

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