EFFECTS OF DIFFERENT DIETARY LEVELS OF VITAMINS AND OLIGOELEMENTS ON BROILERS PERFORMANCE

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Abstract

The aim of this paper was to see the possibilities of improving body weight and the main performance parameters by increasing the proportion of vitamins (mainly in finisher) and selenium in the used premix.

A total of 208 ROSS 308 broiler chicken were studied and divided into 13 pens per each batch (control and experimental). The administered feed complied with the nutritional recommendations of the growth guide, with the exception of feed administered to the experimental batch. The latter had a higher content of selenium and vitamins, especially in the finisher phase.

The end results show significant differences in terms of body weight dynamics up to the age of 14 days between the control batch and the experimental one. The difference decreases with age, and upon slaughter the experimental batch has a weight higher by 0.79%.

The use of 1,25 hydroxycholecalciferol and the increase in the proportion of vitamin E in all growth phases and all vitamins in the finisher period determined a reduction by 3.3% of FCR and by 4.4% of EBI and EPEF compared to the control batch.

Key words: 1,25 hydroxycholecalciferol, vitamin E, vitamin B12, selenium, broiler

INTRODUCTION

Although dietary vitamin and mineral requirements for birds have been periodically reestablished [10,11] some aspects of these requirements are continuously questioned.

To fulfill the growing demand for food, the use of highly specialized broilers with genetic potential for growth has increased. The rapid muscle development is not followed by adequate bone support, which remain immature, burdening the locomotor system [5]. As a result, there is an increase in mortality and fractures due to bone fragility and reduction in welfare, leading to significant economic losses [3]. The formulation of specific diets using vitamin D and its metabolites has been shown as an alternative to reduce these problems.

The vitamin D content available in raw materials used in diets is usually ignored during formulation, and the need for this vitamin is supplied by adding vitamin supplements. As vitamin D_2 (ergocalciferol) potency is about 10 times lower than vitamin D_3 (cholecalciferol) for poultry, the last one is often used. To reach its main metabolically active form, 1,25-dihydroxycholecalciferol (1,25$(OH)_2D_3$), vitamin D_3 must be hydroxylated first in the liver into 25-hydroxycholecalciferol (25$(OH)D_3$), then in the kidneys [13] 1,25$(OH)_2D_3$ has an important role in calcium and phosphorus homeostasis, bone growth and remodeling, and in the immune system [7,8]. Castrol [5] discover a significant improvement in weight gain and feed conversion ratio when broilers were fed 1 and 2 μg 1,25$(OH)_2D_3$/kg at 42 days. One of the most frequent stressors in broiler farms is high stocking density, because the farmers tend to reduce housing and equipment costs by overcrowding the birds, which negatively affects broiler performance and health [12]. Many studies have reported that the inclusion of vitamin E in broiler diets not only reduces oxidative stress, but also improves the overall performance, as demonstrated by the higher body weight gain and reduced feed conversion ratio of broilers

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fed vitamin E [1]. Vitamin E and selenium appear to participate in similar nutritional and biochemical relationships. They act as immuno-stimulatory agents and protect against oxidative damage. Free radicals are scavaged by vitamine E as a first line defence and thereby glutathion peroxidase of which selenium is a part.

MATERIALS AND METHODS

The research was carried out in a farm in Bacau county. 208 ROSS 308 broiler chicks were studied per each batch (control and experimental). The chicks were raised on the ground, in 13 pens of 16 chicks each.

They were fed compound feed from the farm's own compound feed factory. The recipes were made according to the nutritional recommendations in the growth guide. The feed was made and administered according to the 3 growth phases: 0-10 days (starter); 11-24 days (increase) and 25-41 days (finishing).

Both the premix used for the control batch and the premix used for the experimental one come from the same profile company. The vitamin-mineral composition of the premix used in the case of the control group was close to the recommendations of the growth guide (Aviagen – Ross 308, 2019). Regarding the component of the premix used for the experimental group, it was sought to replace vitamin D (5000 IU) with 1.5 mg of hydroxycholecalciferol and a gradual increase in the proportion of vitamin E compared to the growth guide, 2.5 times for the premix intended for the starter phase, 3 times for the growth period and 3.6 times in the premix for the finishing period. The recommended quantity of vitamin B12 for the normal growth and development of the ROSS 308 chicks was 0,017 mg/kg of feed in all growth phases. However, for the experimental batch, the inclusion rate was de 0,022 mg/kg of feed in the growth period premix and 0,025 mg/kg in the finishing phase. Selenium was the only microelement studied and the used premix was enriched with 0.03 Se mg/kg fodder for all growth phases (table 1).

Table 1 Description of the blend of vitamins and minerals from used premix, in acourding with guideline ROSS 308 (2014), inclusion rate 5 kg/t feed

		Starter 0-10 days			Grower 11-24 day			Finisher 25-41 days		
ADDED TRACE MINERALS		Ross 2014	Ctrl.	Exp.	Ross 2014	Ctrl	Exp.	Ross 2014	Ctrl	Exp.
Copper	mg	16	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
Iodine	mg	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1	1.25
Iron	mg	20	40	20	20	40	20	20	40	20
Manganese	mg	120	120	120	120	120	120	120	120	120
Selenium	mg	0.30	0.30	0.33	0.30	0.30	0.33	0.30	0	0.33
Zinc	mg	110	100	110	110	100	110	110	100	110
ADDED VITAMINS										
Vitamin A	UI	13,000	12,000	10,000	11,000	10,000	10,000	10,000	10,000	13,000
Vitamin D3/1,25-hidroxi colecalciferol	UI/ mg	5,000	5,000	1.5	4,500	5,000	1.5	4,000	4,000	1.5
Vitamin E	UI	80	75	200	65	50	200	55.00	50	200.00
Vitamin K (menadion)	mg	3.20	3	2.20	3	3	3	2.20	2	3.20
Thiamina (B1)	mg	3.20	3	2.20	2.50	2	2.50	2.20	2	3.00
Riboflavin (B2)	mg	8.60	8	5.40	6.50	6	6.50	5.40	5	8.00
Niacin	mg	60	60	45	55	60	60	40	4	65
Acid pantothenic	mg	17	15	15	15	15	18	13	15	20
Pyridoxine (B6)	mg	5.40	5	3.50	4.30	4	4.35	3.20	3	5.50
Biotin	mg	0.30	0.2	0.20	0.25	0.2	0.23	0.20	0.1	0.25
Folic acid	mg	2.20	2	1.60	1.90	2	1.90	1.60	1.5	2.20
Vitamin (B12)	mg	0.017	0.012	0.017	0.017	0.016	0.022	0.01	0.010	0.025

The aim of this paper was to see the possibilities of improving body weight and the main performance parameters by increasing the proportion of vitamins (mainly in finisher) and selenium in the used premix.

The parameters tracked in the case of the 2 experimental batches were the following: weekly dynamics of body weight, technological parameters like cumulated feed intake, feed conversion ratio (FCR), total weight gain and technical-economics index European Broiler Index (EBI) and European Production Efficiency Factor (EPEF). They were calculated as follows: EBI = (average daily gain x liveability) / (10 x feed conversion ratio) and EPEF = (live weight at slaughter x liveability) / (feed conversion ratio x age at slaughter) * 100.

The significance of differences means of the values obtained was calculated by using GraphPad Prism 8, descriptive statistics tests & ANOVA single factor followed by post hoc computation.

RESULTS AND DISCUSSION

Table 2 shows the weekly dynamics of body weight of the 2 groups studied. As can be seen, upon population, the one-day-old chicks in the control group weighed 40 g and those in the experimental group 38.44 g, about 4.5 percentage points lower, and very significant statistical differences were observed between batches. This trend was maintained until the the 14th day weigh-in. Starting with the 3rd week of life, the chicks from the experimental group recovered from the difference, reaching an average weight of 18g more than the control group and a coefficient of variability of 3.16% compared to 4.5% of the control group upon slaughter.

Table 2 Weekly dynamics of body weight in studied broilers, as related to the experimental factor graduation

Broilers age (days)	Broiler group (n=208 broilers/group)	Live weight $\bar{X}$ (g)	$\pm s_{\bar{x}}$ (g)	±St Dev (g)	CV. (%)	Min. (g)	Max. (g)	ANOVA significance
1	Ctrl.	40.19	0.29	4.17	10.37	35	45	***, h.s.,
	Exp.	38.44	0.32	4.62	12.02	30	45	$P=5.05*10^{-5}<0.001$
	Exp. Vs. Ctrl (± %)	-4.35						$\hat{F}$ (16.46) > Fα0.001(10.98)
7	Ctrl.	168.06	1.02	14.76	8.78	140	191	***, h.s.,
	Exp.	160.88	1.06	15.32	9.52	140	187	$P=1.57*10^{-6}<0.001$
	Exp. Vs. Ctrl (± %)	-4.28						$\hat{F}$ (23.74) > Fα0.001(10.98)
14	Ctrl.	435.88	1.57	22.68	5.20	385	466	***, h.s.,
	Exp.	424.63	1.76	25.42	5.99	381	473	$P=2.64*10^{-6}<0.001$
	Exp. Vs. Ctrl (± %)	-2.58						$\hat{F}$ (22.68) > Fα0.001(10.98)
21	Ctrl.	856.63	2.34	33.72	3.94	808	923	n.s.,
	Exp.(	850.69	3.55	51.26	6.03	786	940	P=0.1635 > 0.05
	Exp. Vs. Ctrl (± %)	-0.69						$\hat{F}$ (1.95) < Fα0.05(3.86)
28	Ctrl.	1357.44	3.26	47.01	3.46	1290	1463	n.s.,
	Exp.	1353.56	2.45	35.26	2.61	1295	1424	P=0.3421 > 0.05
	Exp. Vs. Ctrl (± %)	-0.29						$\hat{F}$ (0.90) < Fα0.05(3.86)
35	Ctrl.	1893.06	4.21	60.67	3.20	1800	1991	*, s.,
	Exp.	1877.81	4.20	60.60	3.23	1793	2000	P=0.011 < 0.05
	Exp. Vs. Ctrl (± %)	-0.81						$\hat{F}$ (6.58) > Fα0.05(3.86)
41	Ctrl.	2249.31	7.06	101.81	4.53	2117	2536	*, s.,
	Exp.	2267.00	4.97	71.67	3.16	2122	2363	P=0.041 < 0.05
	Exp. Vs. Ctrl (± %)	+0.79						$\hat{F}$ (4.18) > Fα0.05(3.86)

These results suggest the role of vitamin supplementation in grower and finisher phase, on carcass weight. Optimum vitamin levels contributed positively to meat deposition on broilers carcass. Vitamins are essential nutrients for animal development as they participate as cofactors in metabolic reactions and allow a higher efficiency of synthesis systems in the animal body. Vitamin B6, or pyridoxine, is an important component of enzymes that regulate the body's protein metabolism [9].

As Antrison M. mentions in his 2015 dissertation [2], 25-hydroxycholecalciferol had increased potency in broilers compared to cholecalciferol when it comes to improving the bodyweight gain and decreasing the incidence of tibial dyschondroplasia. A greater potency was also observed in broilers when supplemented with 25-hydroxycholecalciferol at lower amounts compared to cholecalciferol [4]. Supplementing the diet with with 25-hydroxycholecalciferol as the sole source of vitamin D improved small intestinal morphology and protective humoral immunity in broiler chickens compared to cholecalciferol during Salmonella Typhimurium infection [6]. To sum it all up, overall performance in chickens can be improved by substituting cholecalciferol with 25-hydroxycholecalciferol as the sole source of vitamin D in their diets.

The synergistic effect of supplementing with 25-hydroxycholecalciferol, vitamins and microelements has contributed to a higher total weight gain after 41 days in the case of the experimental batch, as opposed to the control one. Even though the one-day-old chicks from the experimental batch had a lower average weight and there were significant statistical differences between the two batches, the experimental batch weighed 18 g more on average. The cumulated feed intake after 41 days was higher by 100 g for the control batch. Upon analyzing the technological parameters, a feed conversion index of 1.76 kg/kg growth was noticed in the case of the experimental group, which was 3.3% lower than the control group (tab. 3).

Table 3 Cummulated feed intake, total weight gain and feed conversion ration in studied broilers, as related to the experimental factor graduation

Technological parameter (days)	Broiler groups n=16 barns /group	$\overline{X}$	$\pm s_{\bar{x}}$	±StDev	CV (%)	Min.	Max.	ANOVA significance
Cumulated feed intake 1-41 days (g)	Ctrl.	4015.45	44.32	177.29	4.42	3769	4439	n.s., P=3.34 > 0.05 $\hat{F}$ (3.34) < Fα0.05 (4.17)
	Exp.	3915.35	32.12	128.48	3.28	3671	4083	
	Exp. Vs. Ctrl (± %)	-2.49						
Total weight gain 1-41 days (g)	Ctrl.	2209.13	25.84	103.36	4.68	2073	2491	n.s., P=0.55 > 0.05 $\hat{F}$ (0.37) < Fα0.05 (4.17)
	Exp.	2228.56	18.64	74.54	3.34	2081	2326	
	Exp. Vs. Ctrl (± %)	+0.88						
Feed conversion ratio 1-41 days (kg feed/kg gain)	Ctrl.	1.82	0.01	0.03	1.39	1.78	1.85	***, h.s., P=3.48*10^{-6} <0.001 $\hat{F}$ (32.19) > Fα0.001 (13.29)
	Exp.	1.76	0.01	0.03	1.97	1.71	1.80	
	Exp. Vs. Ctrl (± %)	-3.34						

Based on the total weight gain, we can calculate the average daily gain which, in the case of the experimental group was 54.35 g and 53.88 g respectively for the control group. The technical-economic indices calculated for the experimental group were 4% higher compared to the control group and the differences were significant (tab. 4).

The increase of the value of the economic efficiency indices for the experimental group, can also determine a return on investment, however this aspect was not the objective of the present research.

Table 4 European Broiler Index (EBI) and European Production Efficiency Factor (EPEF)

Technical-economic index	Broiler groups (n=16 barns/group)	$\bar{X}$	$\pm s_{\bar{x}}$	±StDev	C.V. (%)	Min.	Max.	ANOVA significance
European Broiler Index (EBI)*	Ctrl.	281.95	3.95	15.80	5.60	267	317	*, s., $P=0.02 < 0.05$ $\hat{F}$ (5.58) > Fα0.05 (4.17)
	Exp.	294.17	3.34	13.35	4.54	270	332	
	Exp. Vs. Ctrl (± %)	+4.33						
European Production Efficiency Factor (EPEF)**	Ctrl.	287.08	4.02	16.08	5.60	272	332	*, s., $P=0.03 < 0.05$ $\hat{F}$ (5.40) < Fα0.05 (4.17)
	Exp.	299.25	3.36	13.43	4.49	276	322	
	Exp. Vs. Ctrl (± %)	+4.24						

* EBI = (average daily gain x liveability) / (10 x feed conversion ratio)
*** EPEF = (live weight at slaughter x liveability) / (feed conversion ratio x age at slaughter) * 100

CONCLUSION

The use of 1,25 hydroxycholecalciferol versus vitamin D3 and increasing the level of vitamins E and B12 one side of Se, have led to a better feed conversation ratio and total weight gain. The use of 1,25 hydroxycholecalciferol and the increase in the proportion of vitamin E in all growth phases and all vitamins in the finisher period determined the reduction by 3.3% of FCR and by 4.4% of EBI and EPEF compared to the control batch.

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