EFFECT OF FEEDING VITAMIN D AND CAROTENOIDS ON PERFORMANCE PARAMETERS OF BROILER BREEDERS

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ABSTRACT

This work was aimed at investigating the effect of the joint effect of vitamin D3 in its hydroxylated form 25-OHD3 and canthaxanthin, on meat type parental flocks performance. These two compounds were added together to the diet, in addition to the technological instructions for the parental flocks. Vitamin D was added at level 69 ppm, i.e. 1 725 IU D3 and canthaxanthin at level 6 ppm. The effect of the administration of these additives on the number of eggs (NE), the number of eggs of hatching quality (HE), and egg weight (EW) was evaluated. Furthermore, the effect of the additives on the mortality and culling of laying females (CH) and the mortality and culling of males (CR) was monitored in the parental flocks, as well as the feed intake of laying hens (FIH) and the feed intake of roosters (FIR). Eggs were evaluated for fertilization and hatchability from individual flocks. Statistical evaluation of the data was evaluated using the Kruskal-

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Wallis method. A beneficial effect of the additives was observed on hatching egg production ($P < 0.05$). Furthermore, the additives had an effect on the reduction of laying hen culling ($P < 0.001$) on one of the three observed farms. The additives also had an effect on the egg hatchability parameter on one of the five farms ($P < 0.05$).

Keywords: parent flock; meat type; vitamin D_3; canthaxanthin; hatchability; hatching egg production

INTRODUCTION

In poultry rearing and breeding, where enormous genetic progress is being made, not only in the meat type of poultry, it is necessary to take special care of the nutrition of these animals. Most companies have established technological guidelines for their hybrids and their parent flocks for optimum production in the context of good breeding economics. But are there ways of taking these already good results even further through nutrition? For parent flocks in particular, nutrition is critically important for the production of hatching eggs and good performing chicks. SAUNDERS-BLADES et al. (2015) reported that most of the nutrients given in the diet are incorporated into the eggs by the laying hens and directly used in embryo development. No new norms have been set recently in mineral and vitamin nutrition for broiler chickens, the most recent NRC standard set for poultry being that in 2012. The question is whether this standard is sufficient for the modern genotypes of both the parent flocks and their offspring which give exceptional growth performance. Here, for example, the recommended dose of vitamin D from that standard can be used as an example, compared to later studies where corrections have already been made.

According to the old NRC (1994), the recommended amount for the lighter white laying type is 300 IU of vitamin D per kilogram of mixed feed per day and therefore 30 IU of vitamin D per day for the normal laying hen. For the brown-hen type, the standard gives a little more, that is 33 IU of vitamin D per day. The higher figure here is due to the higher nutritional status of these hens. In contrast, more recent findings by ATENCIO et al. (2006) set the vitamin D_3 dose at 2,800 IU per animal per day. Here, the research is already focused specifically on meat-type parents. As far as the importance of vitamin D_3 is concerned, it is particularly important for the metabolism and incorporation of Ca and P in the body, where it helps in both the metabolism of absorption and incorporation into the bone itself. It is also of equal importance in the reabsorption of Ca and phosphate by the kidneys (COMBS, 1998). For carotenoids, and here specifically canthaxanthin, their antioxidant properties are of great interest. SURAI et al (2003) describe canthaxanthin as an excellent carotenoid with great antioxidant properties, as well as good potential in preventing lipid peroxidation of many tissues. This is particularly important for developing embryos, which are subjected to extreme oxidative stress during development. The aim of this study was to investigate the effect of these two additives in addition to the amount recommended in the technological guidelines on the parameters of the parental flock and on the parameters of eggs laid by layers of such supplemented flocks, with a focus on fertilization and hatchability of eggs.

The following hypotheses were put forward in this paper:

1. The feed additive based on canthaxanthin and calcifediol has no effect on the number of laid eggs, the number of hatching eggs and their weight, as well as the culling and mortality of laying hens and males in parent flock.

2. The feed additive based on canthaxanthin and calcifediol has no effect on the fertility of hatching eggs and hatchability of chicks.

MATERIAL AND METHODS

Three farms (A, B, C) were evaluated for the data used. For the monitored parameters used (number of laid and hatching eggs, egg weight, mortality and culling of males and layers, and take daily feed intake), data were evaluated once a week throughout the monitoring period. At the same time, different flock ages were taken into consideration and so the results were matched to the same flock age (with and without feeding additives) to eliminate the effect of flock age. For all flocks, feeding and housing conditions were followed according to the technological instructions of the parent flock producer.

Farm A

Parent flocks of ROSS 308 were kept in six halls. There were 18,400 laying females and 2,220 males without additives and 21,600 laying females and 2,580 males with additives in the diet. For egg weight, data for the 28-week observation period were used and for the rest of the parameters for 32 weeks.

Farm B

COBB 500 parents were raised in seven halls. The number of additive supplemented birds was 16,620 females and 1,680 males. The control group without additives had 22,160 laying females and 2,240 males. These flocks were monitored from 27 to 59 weeks of age. Parent flock weight was measured for 31 weeks, egg weight for 19 weeks and all other parameters were evaluated 33 weeks.

Farm C

In this case, ROSS 308 parents were again raised in six halls, as in Farm A. Parameters were evaluated from 26 to 58 weeks of flock age. With supplementation, 18,960 layers and 2,380 males were evaluated, and without supplementation, 18,960 layers and 2,200 males were evaluated. For these flocks, egg weight was evaluated for 32 weeks, males feed intake for only 9 weeks and other parameters for 33 weeks.

Hall equipment and parameters

The same technological equipment was used in all the evaluated halls. The rearing of the parental flock was carried out on deep bedding (straw - mainly cut wheat). Around the laying nests there was a slat system, which normally in parental breeding ensures high hygiene of laid eggs. Feeding for the laying hens was done with a trough feeder system and for the roosters there was the option of both trough feeders and plate feeders, which were placed out of reach of the laying females to prevent the females from eating males feed. The watering system was designed with drip drinkers in all halls. The nests used were automatic emptying nests, followed by a daily collection of eggs laid outside them on deep litter twice a day. Climatic and zootechnical conditions in all halls were ensured by an automatic control unit. This

was particularly important in summer, when the control unit immediately started to adjust the temperature by means of the built-in air conditioning and dampers when the daily temperatures exceeded the optimum.

As far as fertility and hatchability of eggs were concerned, hatching quality eggs suitable for hatching (clean, without cracks) were included. Eggs from farms A and C were evaluated for two production periods and for farm B for only one. Data collection in the hatching facility of the company Trebic s.r.o. (Chropyne) was carried out once a week for both fertility and hatchability and from each flock separately. Only data when the ages of all three flocks could be paired were included in the statistical evaluation, to eliminate the influence of flock age on the results of fertilization and hatchability of eggs.

Farm A

In the first evaluation period (referred to as A1 in the table), which ran for 11 weeks for fertility and 32 for hatchability, 2.5 million eggs were collected as hatching eggs and evaluated in the hatchery from parents not given additives and 2.2 million hatching eggs from parents given additives. In the second production period (A2), evaluated over 23 weeks for hatchability and 7 weeks for fertility, 2.1 million hatching eggs from parents without additives and 1.9 million with additives were evaluated.

Farm B

Here for one production period (B), hatchability was observed for 9 weeks and egg fertilization for 28 weeks. Nearly 3.0 million eggs from parents without additives and 2.2 million eggs from parents with additives were evaluated.

Farm C

Lastly, for the first production period (C1), hatchability was evaluated for 27 weeks, and egg hatchability was evaluated for 14 weeks. The evaluation involved 2.5 million eggs from flocks without additives and 2.3 million eggs with additives added to the parents. The second production period (C2), when for 25 weeks of hatchability and 11 weeks of fertility of hatching eggs were evaluated, more than 2.1 million eggs from swarms without additives and almost 2.0 million eggs from parents with additives were evaluated.

To evaluate these data, the non-parametric Kruskal-Wallis method was used for evaluation throughout the study. To test the given significance, GLM model with LSD test was used to test the data. The program in which the data were evaluated was Unistat® version 10.11.

RESULTS AND DISCUSSION

Effect of additives on parental flock parameters

Neither significant nor non-significant major differences were observed for the feed intake/day parameter, indicating that additives did not have a negative effect. In parental flocks, the aim of the breeder is to ensure that the animals do not take in large amounts of feed and therefore rationing is used. In this way a balanced and healthy flock can be achieved. On farms A, B and C, there were no evident changes in feed intake/day for either males or females. However, in all three cases, intake was slightly increased (in the range of 1-4 g/feed/day). This increase in feed intake was also observed by GARCIA et al. (2002) in their study on the effect of canthaxanthin on egg production related parameters of females (weekly egg production, egg weight and

conversion and feed intake). In this case, they administered canthaxanthin at 60 ppm/kg of feed. This is contradicted by a later study by JOHNSON-DAHL et al. (2017), where, on the contrary, there was a lower weight of supplemented females compared to the control group. However, this phenomenon occurred in older flocks, when, on the contrary, maintaining a lower weight compared to fatter parental flocks is desirable.

Farm A

The results from the number of eggs produced here were the only ones to show a slight increase of 0.3 eggs per hen per week. This increase in egg production was also observed by COTO et al. (2010), when 25OHD3 was given to parental flocks, in parallel with the improvement in parameters such as shell thickness, fertilization and hatchability of eggs. SOUZA et al. (2008) when administered 6 mg of canthaxanthin found improvement in egg fertilization. Another parameter that was significantly improved was the reduction in culling and mortality of females ($P<0.001$), when the same result but not significant in farm C. This could be due, as in the study by KOUTSOS et al. (2003), who found a positive effect on poultry immunity when administering canthaxanthin with lutein (at a dose of 0.8- 38 mg/kg of mixed feed). Furthermore, similar results, but here in terms of vitamin D administration, were observed by KAKHKI et al. (2019) when administering it, a reduction in mortality of parental flocks occured, due to the reduction of fractures and skeletal system diseases.

Table 1. Effect of additives on performance parameters of parent stock on farm A

Parameter	Without aditives	With aditives	P value
Number of eggs per hen per week	4,8	5,1	NS
Number of hatching eggs per hen per week	4,6[b]	4,9[a]	<0,05
Weight of eggs (g)	63,5	63,5	NS
Culling and mortality of laying hens	0,40[a]	0,25[b]	<0,001
Culling and mortality of roosters	0,93	0,87	NS
Daily feed intake laying hens	162	161	NS
Daily feed intake roosters	118	120	NS

On Farm A, the flock was 26-57 weeks old.

Farm B

On this farm, neither a positive nor a negative effect of the addition of vitamin D and carotenoid-based additives was statistically proven in the parental flocks. Higher weekly culling and mortality was also observed in the groups given the additive. Without statistical conclusiveness, however, it is not possible to say with certainty whether this was the effect of the additive or another cause all together.

Table 2. Effect of additives on performance parameters of parent stock on farm B

Parameter	Without aditives	With aditives	P value
Number of eggs per hen per week	4,6	4,5	NS
Number of hatching eggs per hen per week	4,5	4,4	NS
Weight of eggs (g)	63,1	63,4	NS
Culling and mortality of laying hens	0,13	0,14	NS
Culling and mortality of roosters	0,83	1,00	NS
Daily feed intake laying hens	150	151	NS
Daily feed intake roosters	124	125	NS

On Farm B, the flock was 27-59 weeks old.

Farm C

No conclusive result was observed in farm C either. There were identical results for the number of eggs laid and the number of eggs of hatching quality, and for egg weight. However, a reduction was observed with the addition of additives for culling and mortality of the parent flock.

Table 3. Effect of additives on performance parameters of parent stock on farm C

Parameter	Without aditives	With aditives	P value
Number of eggs per hen per week	4,8	4,8	NS
Number of hatching eggs per hen per week	4,6	4,6	NS
Weight of eggs (g)	64,5	64,5	NS
Culling and mortality of laying hens	0,21	0,19	NS
Culling and mortality of roosters	0,64	0,59	NS
Daily feed intake laying hens	174	178	NS
Daily feed intake roosters	130	131	NS

On Farm C, the flock was 26-58 weeks old.

Effect of additives on fertilization and hatchability of eggs

When evaluating the data for the egg fertilization parameter, no statistically positive effect of additives was found. However, an improvement in egg fertilisation can be seen on two of the five farms. ROSA et al. (2012) observed similar results in terms of improvement in parental flock fertility when canthaxanthin was fed at the same level as here (6 mg/kg feed).

A statistically conclusive result can be seen for the egg hatching parameter. Here, on farm A1, there was a significant improvement ($P < 0.05$) of 5% in hatchability with the administration of additives. This agreed with the study by MATILLA et al (2011) where increased supplementation of flocks with 25OHD3 led to higher deposition of

this form of vitamin D in eggs. These eggs then showed better hatchability and chick quality.

Table 4. Effect of additives on fertilisation and hatchability parameters of eggs on individual farms

Farm	Egg fertilisation (%)		P value	Egg hatchability (%)		P value
	Without aditives	With aditives		Without aditives	With aditives	
A1	90,0	93,5	NS	75,4[b]	80,4[a]	<0,05
A2	95,9	96,0	NS	80,6	81,9	NS
B	96,9	96,8	NS	86,3	85,7	NS
C1	94,3	94,1	NS	81,1	81,3	NS
C2	94,5	94,3	NS	83,4	84,1	NS
All farms	94,1	94,7	NS	81,1	82,6	NS

CONCLUSION

When calcifediol and canthaxanthin were administered together and in addition to the technology instructions (i.e. and 100% of the intended need for maintenance and production), several demonstrations of the positive effect of higher doses of these two components were achieved. The following statistically conclusive results can be noted:

Effect of calcifediol and canthaxanthin administration on the parental flock

- When the additives were administered, in one case out of three, there was a 0.15% reduction in weekly mortality and culling of laying hens ($P < 0.001$).
- There was also a significant improvement in hatching egg production ($P < 0.05$) in one case out of three. This was an improvement in this parameter of 0.3 more hatching eggs per week per hen.

Effect of calcifediol and canthaxanthin administration on fertilization and egg hatchability

- In one case out of five, there was a conclusive increase of 5% in hatchability of chicks ($P < 0.05$).

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