ARTICLE / INVESTIGACIÓN

# Epigenetic effects of selenium and vitamin E supplementation in broiler breeder diets on the performance of their progeny

Fatima Mahmoud Ali, Khalid Hamid Hassan*

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College of Agriculture, University of Diyala, Iraq.
Corresponding author: khalidhamid@uodiyala.edu.iq

**Abstract:** Nutritional supplements have been commonly used in the poultry industry last few years. The study aimed to investigate the epigenetic effects of adding vitamin E and organic selenium to the diet of broiler breeders Ross-308 on their progeny meat production performance. The treatments included the control group fed with a standard diet without supplementation (T1), T2 using a standard diet supplemented with 500 mg of vitamin E / kg, T3 using a standard diet supplemented with 0.5 mg of organic selenium (Availa powder) /kg, and T4 using a standard diet supplemented with a mixture of vitamin E and organic selenium in proportions 500 and 0.5 mg/kg respectively. The eggs were collected from each treatment to obtain the progeny reared for 35 periods, and measurements were recorded for meat production and carcass traits. The results showed that the treatments had significant epigenetic effects on body weight at hatching. Hence, T2 had a significantly heavier body weight than T1, while no significant differences were observed between T3 and T4. The result of T2 recorded extremely high feed intake compared with T3. On the other hand, T3 and T4 recorded a hefty weight of breast parts compared with T1 and T2. In conclusion, organic selenium supplementation led to a significant increase in breast weight and a decrease in thigh part weight compared to the control group. In contrast, vitamin E supplementation led to an increase in chick weight at hatch, a reduction of total mortality and an improvement in feed conversion ratio compared to the control group. This refers to the epigenetic effects of organic selenium and vitamin E on progeny traits when added to the breeder diet.

**Key words:** Epigenetics, broiler, selenium supplementation, meat production.



## Introduction

The poultry industry made significant contributions toward world food security by satisfying people's demand for animal protein[1]. Poultry breeding and production is characterized by a short production cycle and invested capital cycle[2]. It is an important issue to obtain high output and high-quality meat at low cost, which needs a good formula for the chicken diet that affects feed consumption, weight gain, and food conversion efficiency[3].

Nutrition is one of the environmental factors that must supply basic requirements for growth, development and survival, and it represents an essential factor that can directly change the phenotypic performance of living organisms, as well as the epigenetic effects in the subsequent generation through the transmission of nutritional influences on genes expression across generations[4,5]. The epigenetic effects resulting from nutrition focused on determining the necessary nutrients in feeding broiler breeders, which pass these elements to the hatching eggs or directly pass the epigenetic marks from the broiler breeder[6].

Epigenetic effects refer to changes and phenotypes that appear on an organism without a difference in the nucleotide sequence through the processes of DNA methylation and modifications in histones. Some of these changes are inherited across generations[7]. The mechanisms are carried out in small pieces of DNA by enzymes and protein complexes, which represent the language of epigenetic effects in response to external factors, and are phenotypically reflected on the cell and then the organism[8]. Epigenetic mechanisms can regulate gene expression through chemical modifications of DNA bases and changes in chromosomal structure[9], including methylation[10]. and modulation of histones[11,12].

Many studies used vitamin E supplementation in the diet of broiler breeders (using levels 100, 200 and 400 mg/kg of diet). They recorded significant increases in the body weight of their progeny at using 200 and 400 mg / kg of diet[13]. In contrast, other studies used different levels of vitamin E supplementation (0, 150, 250 and 350 mg/kg of diet) and reported no significant differences in feed consumption and feed conversion efficiency in their progeny generation[14,15] indicated an improvement in weight gain when selenium was added (0.4 mg/kg) to the diet of broiler at 1-6 weeks of age, (16) indicated no significant differences in weight gain when adding sodium selenite to broiler diets at a 1 mg/kg rate at 15-27 days of age. There are many global hybrids used widely in Iraq to produce broilers for local consumption, and sometimes the broiler industry imports chicks or eggs for hatchery, besides there are many enterprises that reared broiler breeders to produce hatching eggs, and there are many studies aimed to improve their performance in the Iraqi environment[17-20].

Most feed staff used nutritional supplementations to the diet of broiler breeders such as vitamins, minerals, and amino acids to improve broiler breeder flock performance. It did

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not give attention to the effect of these supplementations on the performance of their progeny[21]. Hence, the recent study aimed to determine the effect of vitamin E, selenium and a mixture of vitamin E and organic selenium supplementation on the diets of Ross broilers breeders and their impact on the performance of their progeny.

## Materials and methods

The experiment was conducted in the poultry house of the animal farm in the Department of Animal Production at the College of Agriculture, University of Diyala. Experiment units include 60 hens and 10 cocks of Ross 308 broiler breeders flock at 41 weeks of age, and the flock is housed in floor pens with dimensions of 2 x 1.5 m. According to the breeding company guide, the hens were fed on a diet containing 15% crude protein and metabolic energy 2775 kilocalories/kg feed and in a restricted system weighing 175 g / hen. The flock was divided into four groups, each group for treatment with three replicates (each replicate with five hens).

The treatments included the control group fed with a standard diet without additives (T1), T2 using a standard diet supplemented with 500 mg of vitamin E / kg, T3 using a standard diet supplemented with 0.5 mg of organic selenium (Availa powder) /kg, and T4 using a standard diet supplemented with a mixture of vitamin E and organic selenium in proportions 500 and 0.5 mg/kg respectively. The available powder contains organic selenium and selenomethionine hydroxy analog at a rate of 0.1%.

The treatments were introduced to the groups for three weeks as an adaptation period before hatching eggs were collected for each treatment to obtain the progeny chicks were fed on a standard broiler diet without supplementation, with a starter diet content of crude protein of 22%. Metabolic energy of 2900 kilocalories/kg during the first 21 days, then replaced with diet content crude protein 20% and metabolic energy 3111 kilocalories/kg until the end of the experiment at the age of 35 days.

### Statistical analysis

Experimental data were analyzed according to a Completely Randomized Design, and the significant differences among means were detected using Duncan's Multiple Range Test at the probability of 0.05[22]. The linear model:

$$Yij = \mu + \tau_i + \varepsilon_{ij}$$

Where:

$Y_{ij}$= observation

μ=overall mean.

$\tau_i$=treatment effect (i=1,2,3,4)

$\varepsilon_{ij}$= The experimental error of observation normally distributed with a mean equal to zero and variance equal to σ2e.

## Results

Table 1 shows the significant effects of supplementation treatments on body weight at hatching; hence T2 therapy outperformed the T1 treatment for body weight at hatching, while no significant differences were observed between T3 and T4. There are no significant differences observed among treatments in all following weeks of rearing for body weight; these results may be indicated to active epigenetic effects of vitamin E supplementation to hens diet on the embryonic development only, but not extended to the period after hatching.

Table 2 shows significant differences among treatments in weekly feed consumption; hence T2 outperformed T3 in the first and second week of age, while no significant differences were observed among other therapies. The results appeared no significant differences among averages of treatments in feed consumption during the subsequent weeks of rearing.

Table 3 shows significant differences among treatments for the food conversion rate in the second week. Hence T2 and T4 outperformed the control group, which indicates that epigenetic effects resulting from vitamin E supplementation alone (T2) or in a mixture with selenium (T4) to the diet of broiler breeder hens in the feed conversion rate during the second week while no significant differences observed with the T3, and no significant differences observed among treatments during the following weeks of the rearing period.

Table 4 shows significant differences among treatments for total mortality; hence T2 outperformed T1 and T4 and did not differ significantly from T3. On the other hand, T3 exceeded T1. The results indicate that all of the supplementation treatments outperformed the chicks' viability compared to the control group, which may be a result of epigenetics due to supplementation treatments of vitamin E and selenium in the breeder's diet, which were positively reflected in the progeny viability and reduced mortality.

Table 5 represents that there are significant differences among treatments; hence T1 outperformed T4 in the aspect of dressing percentage T3, and T4, which used selenium supplementation, recorded significantly high breast weight percentage compared with T1 and T2; the differences may be due to epigenetics effect of selenium supplementation in the breeder hens that affect the progeny broiler performance. On the other hand, T1 and T2 outperformed T3 and T4 in the percentage of thigh weight.

## Discussion

The results agreed with (13) who used different levels of vitamin E (100, 200, and 400 mg/kg of diet in the broiler breeders Ross-308and the results pointed to significant superiority of 400 mg supplementation compared to 100 mg during 1-42 days of age. The results did not agree with (13), who used different levels of vitamin E (100, 200 and 400 mg/kg diet) to the broiler breeders Ross-308 diet at 75 weeks of age. They did not record significant differences in their chick's body weight among groups at the hatching.

The results did not agree with (23) when 0.2 mg/kg of hydroxy selenomethionine was added to broiler breeders' diets. In the progeny flock, no significant differences were observed in the weekly feed consumption from 1 to 41 days.

The results agreed with (13) who used vitamin E supplementation in different levels (100, 200 and 400 mg/kg of diet to the diet of broiler breeder hens and recorded significant differences in the progeny groups at level 100 mg of vitamin E / kg of diet supplementation compared to levels 200 and 400 mg of vitamin E/kg of diet during the period 1-21 days of age, and no significant differences were observed in the subsequent weeks of the experiment.

The results agreed with (24) when Selenomethionine (Availia) was used in the diets of Ross 308 broilers at 36

| Age | T1 | T2 | T3 | T4 |
|---|---|---|---|---|
| One day | 47.21 ± 0.17 b | 50.08 ± 1.06 a | 47.97 ± 0.40 ab | 48.26 ± 0.50 ab |
| Week1 | 153.96 ± 4.33 | 159.53 ± 1.84 | 156.77 ± 6.43 | 155.43 ± 4.69 |
| Week2 | 478.70 ± 14.90 | 466.72 ± 4.65 | 446.72 ± 11.97 | 447.40 ± 6.84 |
| Week3 | 954.66 ± 33.47 | 940.66 ± 7.40 | 875.15 ± 22.88 | 925.04 ± 40.13 |
| Week4 | 1619.08 ± 66.63 | 1532.34 ± 11.61 | 1489.48 ± 18.35 | 1492.35 ± 33.27 |
| Week5 | 2218.84 ± 69.15 | 2000.72 ± 145.33 | 2008.79 ± 92.99 | 2117.24 ± 36.94 |

**Table 1.** Means ± standard error of body weight (g) in the broiler progeny that results from supplementation treatments in the diet of the broiler breeders Ross 308 during the rearing period (5 weeks).
T1: standard diet without addition (control): T2 add vitamin E: T3 add selenium: T4 add vitamin E and selenium mixture. According to Duncan's multiple ranges test, means with different letters differ significantly at a probability level of 0.05.

| Age | T1 | T2 | T3 | T4 |
|---|---|---|---|---|
| Week1 | 173.22 ± 5.19 ab | 161.46 ± 1.78 a | 128.34 ± 6.68 b | 152.01 ± 13.39 ab |
| Week2 | 372.11 ± 11.17 ab | 393.64 ± 16.22 a | 344.07 ± 9.12 b | 365.93 ± 12.07 ab |
| Week3 | 722.69 ± 22.01 | 743.29 ± 17.38 | 663.18 ± 8.76 | 675.00 ± 50.00 |
| Week4 | 1175.65 ± 78.54 | 1175.65 ± 120.90 | 1010.86 ± 91.01 | 1092.3 ± 58.99 |
| Week5 | 1092.12 ± 69.34 | 1025.00 ± 34.90 | 983.42 ± 45.91 | 1064.69 ± 31.95 |

**Table 2.** Means ± standard error of feed intake (g/ week) in the broiler progeny that results from supplementation treatments in the diet of the broiler breeders Ross 308 during the rearing period (5 weeks).
T1: standard diet without addition (control): T2: add vitamin E: T3 add selenium: T4 add vitamin E and selenium mixture. Means with different letters refer to significant differences at P≤0.05.

| Age | T1 | T2 | T3 | T4 |
|---|---|---|---|---|
| Week1 | 1.29 ± 0.07 | 1.48 ± 0.02 | 1.18 ± 0.01 | 1.43 ± 0.17 |
| Week2 | 1.14 ± 0.01 b | 1.28 ± 0.05 a | 1.19 ± 0.01 ab | 1.26 ± 0.03 a |
| Week3 | 1.52 ± 0.04 | 1.57 ± 0.02 | 1.57 ± 0.13 | 1.42 ± 0.04 |
| Week4 | 1.79 ± 0.20 | 1.95 ± 0.21 | 1.65 ± 0.16 | 1.94 ± 0.18 |
| Week5 | 1.82 ± 0.11 | 2.79 ± 1.03 | 1.95 ± 0.20 | 1.71 ± 0.09 |

**Table 3.** Means ± standard error of feed conversion rate in the broiler progeny that result from supplementation treatments in the diet of the broiler breeders Ross 308 during the rearing period (5 weeks).
T1: standard diet without addition (control): T2 add vitamin E: T3 add selenium: T4 add vitamin E and selenium mixture. Means with different letters refer to significant differences at P≤0.05.

days of age at 0.2 mg/kg feed; hence they recorded significant differences between supplementation treatments and control in feed consumption. The results did not agree with 13, which added vitamin E at different levels (100, 200, 400 mg / kg of diet) to the broiler breeders Ross-308 used. The progeny appeared to have no significant differences in the weekly feed consumption during 1 - 42 days.

The epigenetic effects of vitamin E did not stabilize until the total rearing period. The results did not agree with (23), who used 0.2 mg/kg of hydroxyl selenomethionine supplementation in the diets of broiler breeders. No significant differences were recorded in the feed conversion rate of their progeny during the rearing period from 1 to 41 days.

The results did not agree with (13) in a study that used vitamin E supplementation in different levels (100, 200 and 400 mg/kg diet) to the broiler breeder diet, and the results did not record significant differences among groups with an aspect of mortality during 1 – 42 days rearing period. And

| Trait | T1 | T2 | T3 | T4 |
|---|---|---|---|---|
| **Mortality** | 8.54 ± 1.89 C | 0.00 ± 0.00 a | 1.93 ± 0.98 ab | 4.92 ± 0.90 b |
| **Male sex ratio** | 47.05 ± 1.51 a | 22.08 ± 4.80 b | 46.32 ± 3.39 a | 29.77 ± 2.99 b |

**Table 4.** Means ± standard error of the total mortality (%) and male sex ratio in the progeny flock result from supplementation treatments in the diet of the broiler breeders Ross 308.
T1: standard diet without addition (control): T2 adding vitamin E: T3 adding selenium: T4 adding a mixture of vitamin E and selenium. Means with different letters refer to significant differences at P≤0.05.



| Traits | T1 | T2 | T3 | T4 |
|---|---|---|---|---|
| Live body weight (g.) | 2307.75± 68.68 | 2455.25 ± 107.98 | 2209.00 ± 42.66 | 2502.25 ± 190.65 |
| Carcass weight (g.) | 1811.50± 68.35 | 1746.00± 103.94 | 1724.25 ± 38.01 | 1739.00± 175.01 |
| Dressing (%) | 78.49 ± 3.63 a | 71.11 ± 6.30 ab | 78.06 ± 1.70 ab | 69.50 ± 9.23 b |
| Breast weight (%) | 35.96 ± 1.26 b | 36.41 ± 0.90 b | 44.09 ± 0.34 a | 42.39 ± 0.47 a |
| Thigh weight (%) | 30.23 ± 1.38 a | 28.59 ± 2.08 a | 23.26 ± 0.50 b | 24.70 ± 1.45 b |
| Heart weight (%) | 0.78 ± 0.04 | 0.74 ± 0.04 | 0.81± 0.04 | 0.75 ± 0.05 |
| Liver weight (%) | 3.24 ± 0.09 | 3.20 ± 0.13 | 3.12 ± 0.11 | 3.50 ± 0.13 |
| Gizzard weight (%) | 1.35 ± 0.06 | 1.40 ± 0.11 | 1.64 ± 0.12 | 1.60 ± 0.13 |

**Table 5.** Means of squares ± standard error of dressing and carcass parts (%) in the progeny of groups of broiler breeders had nutritional supplementation treatments in the diet.
T1: standard diet without addition (control): T2 adding vitamin E: T3 adding selenium: T4 adding a mixture of vitamin E and selenium. Means with different letters refer to significant differences at P≤0.05

the results did not agree with (24) when selenomethionine (Availia) was supplemented to Ross 308 broiler diets at 36 days of age at 0.2 mg/kg. The results differed with (25) who used supplementation of vitamin E and selenium at levels of 200 and 0.3 mg/kg of diet, respectively, to the diet of quail at the age of 1-2 days, as it was noted that there were no significant differences in the total mortality. Shows that there are substantial differences among treatments in respect of sex ratio; hence T2 and T4 appeared to have a significantly low percentage of males in the hatching batch compared with T1 and T3, which indicates that vitamin E supplementation to the diet of breeder hens may have an epigenetic effect in determining the sex of progeny chicks.

The results agreed with (26) who used organic selenium at level 0.3 mg/kg in a broiler diet and recorded a significant increase in breast and thigh weight. The results did not agree with (14), who reported no significant differences in carcass and breast and thigh weight.

## Conclusions

We can conclude from the results of the current study that the organic selenium supplementation led to a significant increase in the weight of the breast and a decrease in the importance of the thigh parts of the carcass compared with the control group. In contrast, the vitamin E supplementation led to an increase in the weight of chicks at hatching, a decrease in total mortality and an improvement in the feed conversion rate compared with the control group. These results indicate the presence of epigenetic effects of organic selenium and vitamin E in the progeny traits when added to the broiler breeder diet, which can be exploited to improve the performance of the progeny resulting from the breeding flock.

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