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Influence of Dietaries Combined Vitamin E and Selenium Powder on Eggs' Fertility and Hatchability in Japanese Quail

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Abstract

This study was conducted at the Sulaimani Polytechnic University, Kalar Technical College, Veterinary Techniques Department, and animal management farm. The objective of the present study was to show the effect of adding different levels of vitamin E and inorganic Selenium (Sodium selenite) on the fertility and hatchability of Japanese quail from Apr 15 2021 to Jul 15 2021. A total number of 128 birds at 12 weeks old Japanese quail (*Coturnix Coturnix Japonica*) were used (96 females and 32 males). These birds were randomly divided into four dietary treatment groups (T); each group was equally subdivided into 8 replicate boxes; each replicate box consisted of 1 male (8 males per group) and 3 females (24 females per group). The quails were housed in vertical boxes and raised under similar environmental, managerial, and veterinarian conditions. The four experimental diets were: 0 = the basal diet (control) with no additions, T1 = 1.0 g vitamin E + selenium mixture/kg diet, T2 = 1.5 g vitamin E + selenium mixture/kg diet, T3 = 2 g vitamin E + Selenium mixture/kg diet. The results showed that the quail birds that were fed supplemented diet with vitamin E + selenium had significantly ($P<0.05$) higher results in fertility and hatchability, and the study indicated a lower significant effect ($P < 0.05$) in embryonic mortality of eggs and higher significant increments ($P < 0.05$) in hatchability of Vitamin E+ Selenium supplemented in T2 with females fed as compared with other treatments and control groups. In conclusion, supplementation of vitamin E +selenium to quail diets is an ameliorative tool in fertility and hatchability traits of Japanese quail.

Introduction

Whether water or fat-soluble, vitamins are the most crucial requirement and complemented organic materials found in large quantities in natural foods such as vegetable oils, raw grains, and nuts ***[1, 2].*** Vitamin E (Vit E) is called an anti-sterility vitamin. Therefore, it is necessary for normal reproduction in many animal species. Vit E is chemically known as tocopherol ***[3],*** and its good sources are liver, meats and eggs. The exact required amount of Vit E has not been known yet; however, it is advised to take 10-30 mg daily.

The most prominent chemical property of Vit E acts as the best active antioxidant vitamin; it removes the oxidative materials in male and female reproductive systems; indeed, its usage raises the reproductive functions' performance and efficiency. Moreover, biochemically, it maintains the structural integrity of muscles and peripheral muscular systems in animals and strengthens the embryonic epithelial tissues of the gonads for proper reproductive function ***[4].***

Latest studies have declared that much consumption of Vit E prevents heart disease development. Since this vitamin was first discovered, many researchers have revealed its nutritional usefulness in people and

livestock and laboratory animal species. Lymphatic capillaries absorb Vit E, and it is transported to the cardiovascular system through lymphatic vessels and ducts; after absorption, the vitamin is mainly stored in the liver tissues. Moreover, the dietary supplementation of this vitamin protects the spermatozoa by maintaining the stability of polyunsaturated fatty acids in the cell membranes ***[3, 4].***

Vit E deficiency may cause different abnormal clinical signs and apparent disorders, which include problems with the circulatory, muscular, neurological, skeletal, cardiovascular, immunological, and reproductive systems ***[5, 6].***

Blood and tissues contain a high amount of Selenium which is affected by dietary selenium intake, Selenium has an extra effect on Vit E, and it reduces the Vit E requirements ***[2]***; it is far required for normal pancreatic functions; for that reason the digestion and absorption of lipids including Vit E, in addition, Selenium is best essential supplemental material, makes the testicular organ functions well and increase the sperm motility. Selenium also facilitates the reserving of Vit E in the blood plasma lipoproteins ***[2].*** Obviously, as in poultry farming, quails (*Coturnix coturnix*) provided the same benefits as chickens, both in meat and eggs; therefore, industrial breeding of quail has been turned out to be widespread. Japanese quail are hardy birds that thrive in small cages and are less expensive to keep.

Galliformes is the order that the Japanese quail belongs to, and this bird is in the family Phasianidae, a genus-species of the common quail ***[7].*** Sexual maturity is considered the fastest type among birds, as females lay eggs when their ages reach 6 weeks ***[8].*** In addition, several studies have shown that sterility in humans and laboratory animals is caused by Vit E deficiency. Cardiac diseases and myopathy are the two main diseases in pigs associated with Vit E and selenium deficiencies; both appear to be involved in nutritional myopathy and sterility; they have roles in the immunity and body protection from heavy metal toxicities. However, insufficient research has been done on the effects of Vit E deficiency, and Selenium or its supplements on the fertility of livestock, especially poultry; therefore, the purpose of this study was to show the effect of dietary Vit E and selenium supplementation on the fertility, hatchability, and embryonic mortality of Japanese quail eggs.

Materials and methods

A. Animal husbandry

The present investigation was conducted at Sulaimani Polytechnic University, Kalar technical college, veterinary techniques department, and animal management farm to evaluate the effect of different quantities of dietary Vitamin E+Selenium supplementation on fertility and hatchability rates of Japanese quail (*Coturnix coturnix Japonica*) from Apr 15, 2021, to Jul 15 2021. A total number of 128, 12 weeks old quails (96 females and 32 males) were used in the study; the quails were randomly allocated to vertical cages (3 females per 1 male in each box), kept in a closed study area; with artificial lighting, and commercial food was given to them (18% crude protein and 2750 ME kcal/kg. diet), they were maintained for 16 hrs. Light and 8 hours of darkness and the study area temperature were controlled at (27-30^{o}C) throughout the study.

B. Egg's collection

The quail eggs were collected twice a day, exactly at 8.0 am and 3.0 pm, from each replicate box; the total number of eggs for all treatment groups was 300 eggs (75 eggs per treatment group). The eggs were transported to the incubation fortnightly or twice a month.

C. Experimental design and treatments distribution

The four experimental diets (for males and females) were: **0.0** = the basic diet (control) without any additions, **T1** = 1.0 g of Vit E + Selenium mixture/ kg feed, **T2**= 1.5 g of Vit E + Selenium mixture/ kg feed, and **T3** = 2.0 g of Vit E + Selenium mixture/kg feed.

D. Source of vitamin E and Selenium

VAPCO Vit E-S was used in the experiment; the imported Vit E + Selenium was obtained from a veterinary and agricultural products company (VAPCO), manufactured in Jordan, a package containing powder weighing 1.0 kg. and each gram composition contains: 20 IU Vit E and 2 mg Sodium Selenite.

E. Hatchability and fertility traits

- **Fertility**

Incubating eggs were set twice a month or fortnightly, and fertility became determined using candling after 15 days of incubation, the fertility rate is the number of fertile eggs divided by the number of eggs put in the incubator, and it was calculated by the following equation ***[9]:***

$$\text{Fertility \%} = \frac{\text{Number of fertile eggs}}{\text{Total eggs}} \times 100$$

- **Hatchability of fertile eggs**

It was determined near the final stage of incubation which is found as follows:

$$\text{Hatchability of fertile eggs} = \frac{\text{Number of live chicks}}{\text{Number of fertile eggs}} \times 100$$

- **Hatchability of total eggs**

It was calculated as the following:

$$\text{Hatchability of total eggs (\%)} = \frac{\text{Number of live chicks}}{\text{Total eggs}} \times 100$$

- **Embryonic mortality %**

It was calculated as the following:

$$\text{Embryonic mortality} = \frac{\text{Number of embryo mortality}}{\text{Number of fertile eggs}} \times 100$$

F. Data analysis

The data were analyzed by the SPSS program (2016) ***[10]***, Completely Randomized Design, and significant differences among the groups were calculated using the Duncan test at a probability level of 5%.

Results and discussion

Table 1 illustrates the mean values of fertility, hatchability, and embryonic mortality percentages in the four treatment groups {T0 (Control), T1, T2, and T3}, in which a significant difference ($P \leq 0.05$) in the treatment (T2) at a level of 1.5gm Vitamin E+ selenium mixture/kg feed in eggs' fertility and hatchability of whole eggs was revealed when compared with other control and treatments' groups. In contrast, no statistical effect ($P \geq 0.05$) was observed among other treatment groups {T0 (control), T1, and T3} regarding these reproductive traits; also there were no differences occurred significantly among the dietary treatment groups (T1, T2, and T3) in hatchability of fertile eggs and between T2 and T3 in egg fertility as well. On the other hand, the dietary treatments recorded the highest significant values in hatchability of fertile eggs and the least

effective in embryonic mortality%, respectively, compared with the control group. There were no differences among the dietary groups T1, T2, and T3 in embryonic mortality%.

Our results agreed with the previous works of ***other researchers [11 - 17]***, who declared that nutritional supplementation of vitamin and Selenium turned into a better enormous improvement in eggs fertility, hatchability, and embryonic viability in chick embryos, Japanese quails (*Coturnix Coturnix Japonica*), Japanese quail breeders and guinea fowl breeders respectively.

In our current study, this improvement in the characteristics mentioned above may be due to a nutrient in the maternal food regimen that can significantly modify chicken embryos and their vitality during hatching and the initial life. Vit E + selenium was suggested for core functionality. Indeed, the abundance of antioxidants inside egg and embryo cells can protect tissues during the oxidative reaction at hatching period ***[14].*** This metabolic rate and oxygen intake processes increase the speed at the time and simply after hatching ***[18].***

It is helpful if a powerful antioxidant system is already in place to prevent an immediate oxidative reaction. Indeed, chicken embryo tissue contains a fairly high proportion of polyunsaturated fatty acids in the lipid fraction ***[19, 20],*** resulting in the need for antioxidant protection ***[21].*** The antioxidant regime of the newly hatched chick includes the antioxidant enzymes superoxide dismutase, glutathione peroxidase, catalase ***[22],*** fat-soluble vitamin E, carotenoids ***[21 - 27],*** as well as selenium ***[28, 29].*** Vitamin E ***[24, 30]***, carotenoids ***[31, 32]*** and selenium ***[28, 30, 33 - 35]*** are transferred from feed into the egg and then to embryonic tissues and their levels in eggs, and embryonic tissues may be regulated with the aid of dietary means ***[22].***

Table-1: Effect of adding vitamin E + Selenium on the mean of fertility, hatchability and embryonic mortality rates in Japanese quail (Mean+SD).

Studied traits	T0	T1	T2	T3	Pr < f
Egg fertility	B 70.52±17.01	B 70.88±8.47	A 94.86±1.05	AB 83.3±10.86	*
Hatchability of total eggs	B 63.96±10.69	B 70.24±11.69	A 91.37± 0.56	B 68.71±9.21	*
Hatchability of fertile eggs	B 78.20±5.54	A 92.70±6.15	A 96.99±0.68	A 92.36±7.30	*
Embryonic mortality	A 21.80±7.33	B 7.30±0.31	B 3.01±0.86	B 7.64±0.50	*

T0=**control**, **T1**= **1.0 g** Vit E + Selenium mixture/kg diet, **T2**= **1.5 g** Vit E + Selenium mixture /kg diet, **T3= 2.0 g** Vit E + Selenium mixture /kg diet. AB= The rows without the same letters are significantly different (P < 0.05).

Furthermore, ***[36]*** who noticed in their study that breeder eggs were provided a 120 mg Vit E/kg diet had higher hatchability rates than those by 30 mg of the vitamin at the age of 29 weeks, and ***[37]*** documented that fertility rate in Japanese quail was significantly reduced in the case of Vit E deficiency. ***[12]*** declared that fertility performance was significantly increased (P < 0.01) by adding Vit E and Selenium together as a supplementary additive dietary feed at a level of 25 and 50 mg/kg with a diet of 1 and 2 mg/kg of Selenium**.** Another group of researchers showed that supplementing the basic feed of male broiler breeders with Vit E at 100 and 200 ppm also increased sperm mobility and fertility [38]. Hens had undoubtedly improved fertility rate when fed with additive selenium at 0.1, 0.2, and 0.4 mg per kg. diet ***[39]***. On the opposite, ***[40]*** discovered that no effect on fertility performance was felt in both turkey hens and tom's breeders in case of providing their feed with selenium supplement. Moreover, the statistical difference in fertility was not found in White Leghorn hens fed with Selenium in the basic feed ***[41]*** as well as our results were in contrast to the finding ***[42]***, who observed that mixed Vit E and Selenium as an additive supplementation in broiler hens had no statistically significant effect on rates of hatchability and fertility. There was no traceable literature linked to

opposition reports on supply to Japanese quail breeders. Other observations have shown that supplementation with much higher Selenium increased GSH-Px activity in chicken blood ($P < 0.05$) ***[43].***

On the other hand, ***[29]*** indicated that Selenium plays a critical role in increasing fertility, improving the embryo and improving the hatchability of poultry. In addition, selenium material deposits in the egg and is scattered in growing tissues during embryogenesis ***[28, 44].*** This improvement may be due to the Selenium, which can scavenge oxygen free radicals and lipid peroxidase and reduce the extent of tissue damage from the hatching condition ***[29].***

The increment in the fertility rate of Japanese quail is related to higher Vit E and inorganic selenium additive. In addition, Japanese quail sperm contain high rates of long-chain polyunsaturated fatty acids (PUFAs). These very high concentrations of PUFAs in sperm are required to maintain fluidity and flexibility, the physical properties necessary to maintain sperm mobility and sperm fusion during the fertilization process. This is believed to be an essential cause of male unsaturated.

The enzyme glutathione peroxidase, which contains Vit E and Selenium, plays an important role in protecting sperm membrane lipids from peroxidation and maintains sperm structural integrity ***[22].*** Quail birds fed a low-Vit E soybean meal diet significantly reduced hatchability ***[37]. [45]*** found that male breeding diets containing 2% flaxseed oil were formulated with Vit E (50 and 250 mg/kg) and Vit C (200 mg/kg) to increase hatchability. Selenium supplementation in varying amounts increased hatchability, as shown ***[40, 46, 47]*** in turkeys and ***[39]*** in breeding hens. Ganpule and Manjunatha (2003) ***[48]*** found that the addition of 0.1 ppm organic selenium mixed with 75 ppm Vit E increased the hatch rate significantly ($P < 0.01$). Vit E and selenium help avoid lipid peroxidation during fetal developmental stages, which reduces the rate of late fetal death.

Conclusions

The findings of this study indicated that the improvement of some reproductive features such as eggs' fertility, hatchability, and embryonic viability rates of the bird Japanese quail was confirmed by adding supplemental dietary Vit E and Selenium (Sodium selenite) to the diet. It is obvious that the present study is considered the potential one has performed on these relations, so the current research has shown the significant effect of a specific level of combined Vit E and selenium supplementation powder on the above-studied traits in this type of bird in a particular group which was 1.5 g Vit E and selenium/kg feed. Scientific management care should be taken into consideration. More and less Vit E and selenium powder in the ingredient of the Japanese quail nutrition decrease most studied reproductive performances. Therefore, it is recommended that this recovery be applied to different species of poultry birds and others to raise the fertility, hatchability, and chick survivability rates; however, more studies are essential to make these findings more extended.

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