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The Impact of Different Levels of Vitamin E and Selenium on the Performance, Quality and the Hatchability of Eggs from Breeding Japanese Quails

Research Article

M. Abbaszadeh Mobaraki[1] and H. Aghdam Shahryar[2*]

[1] Young Researchers and Elite Club, Shabestar Branch, Islamic Azad University, Shabestar, Iran
[2] Department of Animal Science, Shabestar Branch, Islamic Azad University, Shabestar, Iran

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*Correspondence E-mail: ha_shahryar@iaushab.ac.ir

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ABSTRACT

The purpose of the present study was to evaluate the impact of vitamin E and selenium (Se) supplementation on the performance, egg quality and hatchability of eggs from Japanese breeding quails. The experiment was conducted over a 60 day period using 135 quails in a completely randomized design (CRD) with two levels of vitamin E and two levels of selenium (80 mg/kg of vitamin E+0.2 mg/kg organic selenium and 160 mg/kg vitamin E+0.4 mg/kg organic selenium). For each treatment, 3 replicates were considered. Each replicate included 15 quails (12 females and 3 males). Experimental results indicated that feed intake, shell thickness, the weight of egg whites and the percentage of egg hatchability stored for 7 days were significantly affected by the treatments (P<0.05). However, it was found that the treatments of the study did not have significant impacts on other features, i.e. egg production percentage, feed conversion ratio, egg shell percentage, yolk weight percentage, international quality unit (IQU), Haugh unit, percentage egg hatchability in 10 days storage. The results of the experiments revealed that the use of vitamin E and selenium (160 mg/kg of vitamin E+0.4 mg/kg organic selenium) had the highest impact on performance traits, percentage hatchability and egg quality traits.

KEY WORDS egg quality, hatchability and Japanese quail, performance, vitamin E and Se.

INTRODUCTION

The combination of vitamin E and the mineral selenium is considered to be a natural antioxidant compound which is most widely used in the poultry industry. Such compounds have been reported to have synergistic effects for the syntheses of antioxidant enzymes have been androgenic. Vitamin E is a fat soluble compound whose natural antioxidant characteristic is strong. Selenium is deemed to be an essential nutrient in the diet of laying hens. Laying hen need selenium for their daily feed intake of about 0.05 to 0.08 ppm (NRC, 1994). It can be argued that the supplementation of diet with antioxidants can stimulate avian immune system (Sahin *et al.* 2010). As a case in point, Sahin and kucuk (2001) found that adding vitamin E and selenium in the diet of Japanese quail under heat stress conditions enhanced feed intake, body weight gain and feed conversion ratio (FCR). They contended that increased levels of these supplements led to better results. Nevertheless, Puthpongsiriporn *et al.* (2001) argued that supplementing the diet of laying hens with vitamin E might have some undesirable impacts. High ambient temperature reduces egg quality. However, vitamin E has a significant impact on Haugh unit (HU) through the antioxidant property and it can protect egg protein and lipid against oxidation. Kucuk *et al.* (2003) found that adding vitamin E (250 mg/kg) to the diet of Japanese quail under low temperature stress enhanced HU which was not the case with the control group. In another experiment, Mohiti-Asli *et al.* (2008) observed that adding 200 mg/kg vitamin E to the diet of layer hens had a significant impact on the total production, egg weight, feed intake and FCR. However, Arpášová *et al* .(2009) who examined the impacts of organic and inorganic selenium in laying hens on egg yolk weight and egg white weight; did not find any significant differences between the two kinds of diets. They noted that increased levels of selenium reduced the egg shell.

Renema (2004) studied 36 to 56-week laying hens and concluded that including selenium in the diet resulted in a significant change in egg shell weight. Malek Mohammadi *et al.* (2009) contended that different levels of vitamin E and selenium had no significant impact on egg yolk weight. Mazaly *et al.* (2004) studied the effect of different diets including 5 percent of oil and two levels of vitamin E on egg laying hens but they could not detect any significant differences on egg production and egg weight.

Kirunda *et al.* (2001) claimed that including vitamin E in the diet of laying hens under heat stress had a positive impact on HU. It was argued that vitamin E is required for normal hatchability (NRC, 1994). Both selenium and vitamin E supplementation resulted in enhanced vitelline membrane strength of fresh eggs (Scheideler *et al.* 2010). Payne *et al.* (2005) did not find any significant effects of feeding layer hens with different levels and sources of selenium on egg production percentage. Papazyan *et al.* (2006) argued that selenium increases the ratio of egg antioxidant; consequently, it improves egg storage time and the potential hatchability of eggs.

Edens (2002) argued that selenium enhances broiler growth, FCR, meat quality, feather growth and moisture retention in meat. He contended that using organic selenium enhances semen quality and reproduction. Consumption of sodium selenite as a source of selenium increases sperm count per ejaculate in males and the percentage of normal spermatozoa and abnormal sperm motility decrease in ejaculate.

In another study, Edens (2001) reported that using organic selenium improved egg hatchability up to 10% after storing for 10 days. However, he argued that it was not the case with eggs produced by hens on sodium selenite diet. Hence, using organic selenium rather than inorganic selenium (sodium selenite) results in more than four chicks per hen in the flock.

In brief, based on previous research findings, it can be argued that vitamin E has a remarkable impact on egg production (Scheideler and Froning, 1996). Experimental research studies indicate that egg production remarkably decreases in laying hens as a result of feeding the birds with a diet lacking vitamin E (Tengerdy and Nockels, 1973). Gaal *et al.* (1995) reported that vitamin E magnitude in egg yolk significantly affects the antioxidant defense system of embryos, embryo stages and chicks early life. Surai (2000) argued that that selenium supplementation in poultry diets affects the selenium content of eggs, embryo growth and antioxidant status of broiler on hatch.

Furthermore, significant increases of pH whites were detected as a function of increasing storage time and temperature (Baylan *et al.* 2010). In Europe and the United States, adding inorganic selenium to the diet up to 0.5 mg/kg is allowed. However, adding organic selenium up to 0.3 ppm is allowed (Pavlovic *et al.* 2009). A positive impact for organic selenium on egg freshness was also reported by Kralik *et al.* (2009). Wakebe (1998) reported that dietary addition of 0.3 ppm SEL-PLEX resulted in a delay in HU reduction of eggs stored for 7 days. It was reported that organic selenium has a positive effect on eggshell thickness (Klecker *et al.* 2001) which is not the case with inorganic selenium administered together with vitamin E (Sahin *et al.* 2003).

The impetus behind the present study was to investigate the impacts of different dietary levels of vitamin E-Se supplementation on the performance, egg quality and hatchability of eggs produce by Japanese quails (*Coturnix coturnix Japonica*).

MATERIALS AND METHODS

In order to investigate the impact of vitamin E and Se supplementation on the performance, quality and hatchability of eggs produced by breeding Japanese quails, 135 day-old Japanese quail chicks were distributed into 9 experimental units (standard three story cage) according to a completely randomized design and at the age of 8 weeks were selected and were fed for 60 days.

The dietary treatments included in the study were:
1) corn-soya based basal diet (BD) with no supplement
2) BD + E and Se (80 mg/kg of vitamin E and 0.2 mg/kg organic selenium)
3) BD + E and Se (160 mg/kg vitamin E and 0.4 mg/kg organic selenium)

The temperature and relative humidity of the rearing house were 33 + 2 ˚C and 65%, respectively. Quails were maintained on a 16:8 hr light:dark schedule during the trial. Feed and water were freely available to the birds at all times.

Feed intake and feed conversion ratio were calculated on daily and weekly basis. For each group of quails, the number of eggs and the average weight of an egg were recorded on daily and weekly basis, respectively. On three consecutive days at the end of the experiment, 3 eggs per replicate were collected for egg quality assessment. The eggs were transported to the lab and weighed by means of a precision scale (0.01 g). Eggshells were washed with water, dried in an oven at 60 ˚C for two days, weighed and then the eggshell percentage was calculated. A vernier caliper was used to measure eggshell thickness at three different eggshell locations. A micrometer was used to determine the height of the thick albumen. The following formula suggested by Stadelman and Cotterill (1986) was used for calculating the Haugh unit (HU):

$HU= 100\ Log(H+7.57-1.7W^{0.37})$ (Eq. 1)

Where:
H: stands for the albumen height (mm).
W: refers to egg weight (g).
7.57 and 1.7: considered to be the correction factors for albumen height and egg weight, respectively.

International quality unit (IQU) (Kondaiah *et al.* 1983), as an alternative for HU in egg quality measurement, was calculated by the following formula:

$IQU= 100\ Log(H+4.18-0.8989EW^{0.6674})$ (Eq. 2)

Where:
EW: stands for egg weight.
4.18, 0.8989 and 0.6674: constants.

At the end of the experiment, eggs produced by the quails were collected and stored under the same conditions: 14-17 ˚C, 70% wet rotate 45 degrees in two directions and they were kept for 7 and 10 days. Then, they were transferred to the incubation system. Data were analyzed by GLM procedure of SAS (2004). The treatment means were compared with each other by the Duncan test at 5% probability level.

RESULTS AND DISCUSSION

Performance traits

Based on the results (Table 2), feed intake of the quails was significantly affected by the dietary treatments (P<0.05). However, the effect on egg production (%), egg weight (g) and FCR (Table 2) was not significant. The results of this study with respect to FCR are agree to those of Sahin and Kucuk (2001) and Mohiti-Asli *et al.* (2008). For feed intake, however, the results of this study are not in line with those of Sahin and Kucuk (2001). The findings of this study are consistent with the results of Adebiyi (2011) with respect to feed intake but different from those with respect to feed conversion ratio.

For egg production, the results of this study are parallel to the results of Payne *et al.* (2005). Moreover, the results of this study acknowledge the results of Edens (2002) for positive impact of selenium supplementation on FCR. Also the findings of this study corroborate the results of Tengerdy and Nockels (1973) with regard to the control groups with the lowest egg production.

Adebiyi *et al.* (2014) found that vitamin E and selenium supplementation in the diet of laying eggs resulted in significant differences among the groups with regard to egg production. However, many studies failed to find a significant impact of dietary Se supplementation on daily egg production and egg weight (Chantiratikul *et al.* 2008; Mohiti-Asli *et al.* 2010). Stępińska *et al.* (2012) found that turkey hens fed by organic selenium had higher average egg weight than the turkey hens fed by inorganic selenium. Zduńczyk *et al.* (2013) observed that using different levels of selenium and vitamin E in dietary laying hens had no significant impact on the total egg weight and daily egg production. Also, the results of this study, for egg weight and egg production, confirm those of Chantiratikul *et al.* (2008), Mohiti-Asli *et al.* 2010 and Zduńczyk *et al.* (2013). Naylor *et al.* (2004) noted that adding selenium to the diet reduces feed intake and feed conversion ratio. It was argued that selenium is essential for metabolism and action of thyroid hormones.

Abdel-Maksoud (2006) argued that diet supplementation with vitamin E enhances egg production percentage in laying hens inasmuch as it reduces the side effects of high ambient temperatures in summer months. He mentioned that vitamin E can have a remarkable role by protecting liver and other organs against oxidative damage.

Quality traits of quail eggs

The results of the current experiment with respect to the impact of vitamin E and selenium supplementation on the egg quality traits of breeding Japanese quails are illustrated in Table 3. Egg shell thickness and egg white weight (Table 3) were significantly affected (P<0.05) by the dietary treatments. The lowest and highest egg shell thickness were related to 160 mg/kg vitamin E + 0.4 mg/kg organic selenium and 80 mg/kg vitamin E + 0.2 mg/kg organic selenium groups, respectively. The minimum and maximum amounts of egg white weight were achieved by 80 mg/kg vitamin E + 0.2 mg/kg organic selenium and the control groups, respectively. As shown in Table 3, no significant impact was detected for the other quality traits. The findings of the present study for egg weight and egg production are in line with those of Mazalli *et al.* (2004). The results of this study corroborate those of Gjorgovska *et al.* (2012) with regard to egg white and yolk weight and egg shell percentage.

Table 1 Composition and calculated analysis of the basal diet

Ingredients	Unit	Amounts	Calculated analysis		
Corn	%	42.13	Metabolizable energy (ME)	kcal/kg	2914
Wheat	%	15.00	Crude protein	%	18.89
Soybean meal (CP, 44%)	%	31.00	Calcium	%	2.47
Canola oil	%	4.00	Available phosphorus	%	0.35
Limestone	%	5.30	Lysine	%	1.15
Dicalcium phosphate	%	1.74	Methionine	%	0.46
Mineral premix[a]	%	0.25	Methionine + cysteine	%	0.74
Vitamin premix[b]	%	0.25	Linoleic acid	%	1.43
Salt	%	0.20	Tryptophan	%	0.25
DL-methionine	%	0.08	Threonine	%	0.77
L-lysine	%	0.05	-	-	-
Total	100		-	-	-

[a] Per kg contains: Manganese: 60000 mg; Zinc: 50000 mg; Copper: 10000 mg; Iron: 30000 mg; Iodine: 1000 mg; Selenium: 100 mg; Cobalt: 100 mg and CaCO3: 3000 gm.
[b] Per kg contains: vitamin A: 10000000 IU; vitamin D_3: 2000000 IU; vitamin E: 10000 mg; vitamin K_3: 1000 mg; vitamin B_1: 1000 mg; vitamin B_2: 5000 mg; vitamin B_6: 1500 mg; vitamin B_{12}: 10 mg; Pantothenic acid: 10000 mg; Niacin: 30000 mg; Folic acid: 1000 mg; Biotin: 50 mg and Choline: 300000 mg.
CP: crude protein.

Table 2 Effect of vitamin E and selenium supplementation on the performance of breeding Japanese quails

Treatments	Egg production (%)	Egg weight (g)	Feed intake (g/day/bird)	FCR
Control	75.70	12.03	29.03[a]	4.93
Vitamin E and Se (80 mg/kg vit. E+0.2 mg/kg Se)	79.70	11.68	27.51[a]	3.99
Vitamin E and Se (160 mg/kg vit. E+0.4 mg/kg Se)	80.93	11.69	24.93[b]	3.99
P-value	0.45	0.46	0.005	0.21
SEM	2.9	0.21	0.55	0.39

FCR: feed conversion ratio.
The means within the same row with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Table 3 Effect of vitamin E and selenium supplementation on egg quality traits produced by breeding Japanese quails

Treatments	Egg weight (g)	Egg shell thickness (mm)	Egg shell (%)	Yolk weight (g)	Egg white weight (g)	IQU	Haugh unit
Control	12.03	0.25[ab]	7.87	3.95	7.58[a]	62.04	90.43
Vitamin E-Se (80 mg/kg vit. E+0.2 mg/kg Se)	11.68	0.26[a]	7.95	3.87	7.35[b]	63.15	90.17
Vitamin E-Se (160 mg/kg vit. E+0.4 mg/kg Se)	11.69	0.24[b]	7.81	3.82	7.39[b]	64.15	91.36
P-value	0.46	0.03	0.73	0.66	0.01	0.83	0.33
SEM	0.21	0.003	0.13	0.10	0.04	2.44	0.54

IQU: international quality unit.
The means within the same row with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

The findings of the present study on egg weight mismatch those of Gjorgovska *et al.* (2012) who demonstrated that dietary supplementation of organic selenium in laying hens had a significant effect on egg weight. Since selenium supplementation to the diet reduces albumen deterioration; as a result, the loss of carbon dioxide slows down; and hence, albumin quality is maintained (Wakebe, 1998). Thus, it can be argued that the improvement of shell thickness might be attributed to the increased bioavailability of calcium supplementation activities of vitamin E. Like the findings of the present study, Malek Mohammadi *et al.* (2009) did not find any significant impact on egg yolk weight. Also, the results of this study concerning the increasing effect of the 160 mg/kg vitamin E + 0.4 mg/kg organic selenium supplementation on HU confirm those of Kucuk *et al.* (2003).

Hatchability

The impacts of vitamin E and selenium supplementation on the hatchability of eggs (%) after 7 and 10 days of storage are illustrated in Table 4. As can be seen from the Table, there are significant (P<0.05) differences between the dietary treatments for the hatchability of eggs stored for 7 days, with the highest (61.80%) and lowest (51.04%) values for 160 mg/kg of vitamin E + 0.4 mg/kg organic selenium and the control groups, respectively.

Table 4 The impacts of vitamin E and selenium supplementation on (%) after 7 and 10 days of storage

Treatments	7 days storage	10 days storage
Control	51.04[b]	63.13
Vitamin E and Se (80 mg/kg vit. E+0.2 mg/kg Se)	60.87[a]	71.64
Vitamin E and Se (160 mg/kg vit. E+0.4 mg/kg Se)	61.80[a]	72.94
P-value	0.004	0.56
SEM	1.54	6.72

The means within the same row with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

The highest (72.94) and lowest (63.13), but statistically not significant, hatchability of eggs stored for 10 days was related to the groups fed 160 mg/kg of vitamin E + 0.4 mg/kg organic selenium, respectively. The results of the present study with respect to the hatchability of eggs stored for 7 and 10 days are similar to those of Edens (2001) and Renema (2004). The results of this study confirm the report of Latshaw and Osman (1975) who found that synthetic selenium compounds (0.2 mg/kg) remarkably affected the hatchability of eggs.

CONCLUSION

Based on the experiments and the statistical analysis of the collected data, The conclusion to be made for the present study is that vitamin E and Se (160 mg/kg vitamin E + 0.4 mg/kg organic selenium) can reduce feed intake, feed conversion ratio; However, it enhances egg production, IQU and hatchability in laying Japanese quail.

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