Effect of dietary vitamin E and organic selenium supplementation on reproductive performance of Japanese quail breeders

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ABSTRACT

This study was conducted to evaluate the effect of different dietary level of vitamin E and organic selenium on the reproductive performance of Japanese quail breeders. A total of 252 Japanese quail birds aged 20 week with an average of 80 per cent egg production were used in this study. Trial birds were randomly divided into seven groups having male: female mating ratio of 1:3. Experimental birds were randomly divided into seven groups viz. T1- Control: Basal diet (standard Japanese quail ration), T2 - Basal diet with vitamin E 150mg/kg, T3 - Basal diet with vitamin E 300 mg/kg, T4 - Basal diet with organic selenium 0.3mg/kg, T5 - Basal diet with organic selenium 0.6mg/kg, T6 - Basal diet with combination of vitamin E 150mg/kg and organic selenium 0.3mg/kg, T7 - Basal diet with combination of vitamin E 300mg/kg and organic selenium 0.6mg/kg. The highest fertility (91 percent) and hatchability (Total eggs 80 percent; fertile eggs 89 percent) percentage were observed in experimental group which received vitamin E 150 mg per kg and selenium 0.3 mg per kg while the least fertility (78 percent) and hatchability (Total eggs 62 percent; fertile eggs 80 percent) percentage were recorded in the control group. From this study it can be concluded that dietary supplementation of vitamin E and organic selenium had highly significant ($P<0.01$) improvement infertility and hatchability percentage of Japanese quail.

Key words: Japanese quail breeder, vitamin E, organic selenium, fertility, hatchability

INTRODUCTION

Vitamin E is recognized as an essential nutrient for all species of animals as well as humans. Vitamin E is a generic term for a group of tocopherols and tocotrienols. Among the four tocopherols (α, β, γ and δ) and four tocotrienols (α, β, γ and δ) identified α-tocopherol is the most biologically active form and available in high quantities from vegetable oils, unprocessed cereal grains, and nuts. Vitamin E is an excellent biological chain breaking antioxidant in biological membranes, which prevents free radical, induced oxidative damage by trapping reactive oxyradicals (Packer, 1991).

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Selenium a trace element is frequently added to animal diet as a supplement for the maintenance of reproductive functions and a deficiency in dietary selenium causes decrease in sperm concentration, sperm motility, and sperm capacity in humans, lab animals and farm animals, including poultry. Selenium is an essential component of selenium dependent glutathione peroxidase (GSH-Px) which protects sperms against oxidative damage. GSH-Px plays a central role in antioxidant defense in the cell by removing hydrogen peroxide, and lipid hydroperoxide is formed during metabolism and superoxide radical dismutation.

Selenium and vitamin E are interrelated. Both are needed by animals and both have metabolic roles in the body in addition to an antioxidant effect. In some instances, vitamin E would substitute in varying degrees for selenium or vice versa. However, there are deficiency symptoms that respond only to selenium or vitamin E. Although selenium cannot replace vitamin E in nutrition, it reduces the amount of vitamin E required and delays the onset of vitamin E deficiency symptoms.

Japanese quail (*Coturnix coturnix japonica*), considered a tiny avian species has a high market value for its table delicacy. Japanese quail was first domesticated in Japan and occupy a significant position in poultry production activities. Efficient Japanese quail production is based on the feeding of a well-balanced diet to highly productive line of birds. In this respect, antioxidants play an important role in maintaining bird health, productive and reproductive performance (Surai, 2002) of Japanese Quails.

MATERIALS AND METHODS

Experimental Design

The experimental study was conducted at the Department of Poultry Science, Veterinary College and Research Institute, Namakkal, TamilNadu. A total of 252 Japanese quail birds of 20 weeks age with an average of 80 per cent egg production were selected for the trial. Feed ingredients used for formulation of ration were analysed for vitamin E and selenium content in addition to proximate composition. Vitamin E analysed by HPLC system procedure as described by Surai (2000) and selenium analysed by flourometric method procedure as described by AOAC (2000).

The Japanese quail breeder diets were formulated as per the standard prescribed by Shrivastav and Panda (1999), Central Avian Research Institute, Izatnagar except the vitamin E and selenium level in basal diet. Vitamin E in the form of dl-α-tocopheryl acetate, 50 per cent (Promix E, Addisseo company) and organic selenium in the form of Sel-Plex (Alltec Inc.) containing mainly as selenomethionine were incorporated into the basal diet either independently or simultaneously in the basal quail diet to form seven experimental groups. The ingredients and nutrient composition of Japanese Quails breeder Female and breeder male diets are presented in Table 1.

Experimental birds were randomly divided into seven groups with three replicates as follows

Treatment groups	Experimental diet	No. of birds	
		Male	Female
T_1	Basal diet (control)	9	27
T_2	Basal diet + vitamin E 150 mg/kg	9	27
T_3	Basal diet + vitamin E 300 mg/kg	9	27
T_4	Basal diet + selenium 0.3 mg/kg	9	27
T_5	Basal diet + selenium 0.6 mg/kg	9	27
T_6	Basal diet + vitamin E 150 mg/kg + selenium 0.3 mg/kg	9	27
T_7	Basal diet + vitamin E 300 mg/kg + selenium 0.6 mg/kg	9	27

The quails were reared in cages under standard managemental practices throughout the experimental period of eight weeks with male to female ratio of 1:3. They were provided with a photoperiod of 16 hours per day. The experiment was approved by the Institutional Animal Ethical Committee of TANUVAS.

Eggs Collection

Eggs from all the experimental groups were collected twice daily at 9 pm and 7 am. Soon after collection, eggs were examined for shell intactness, weight and size. Eggs unfit for hatching were discarded and the remaining eggs fit for setting were fumigated with formaldehyde gas for 20 minutes at "2X" concentration. They were stored at 12±1°C with 75±5 per cent relative humidity. Eggs with standard weight and shell quality were selected for setting in incubator after collection of 100 eggs per group.

Incubation and Hatching

Eggs were incubated in automatic incubator with a temperature of 99.5° F and relative humidity of 60 per cent. Egg turning was stopped three days before hatching and eggs were transferred to the Hatcher with a temperature of 98° F and 70 per cent humidity.

Fertility and Hatchability of Eggs

Hundred eggs from each replicate were placed in incubator. The usual recommended temperature and humidity were followed by turning during incubation period. The fertility assessment was performed by breaking all the unhatched eggs at the end of experimental period. Fertility and total Hatchability of eggs were calculated

Statistical Analysis

Statistical analysis was done by Completely Randomized Block Design as per Snedecor and Cochran, (1994).

RESULTS AND DISCUSSION

The mean fertility and hatchability percentage (both total eggs and fertile eggs) early and late embryonic mortality of Japanese quail eggs as influenced by dietary

supplementation of vitamin E and organic selenium are presented in Table 2.

Effect of vitamin E and selenium on fertility of Japanese quail breeder

The different levels of vitamin E and organic selenium supplementation showed highly significant (P<0.01) improvement in fertility percentage among treatment groups. The combination of vitamin E (150 mg/kg) and organic selenium (0.3 mg/kg) supplemented group (T_6) had significantly (P<0.01) increased fertility percentage compared to all other treatment groups. The control group had significantly (P<0.01) poor fertility percentages.

Kling and Soares (1980) observed that vitamin E deficiency in Japanese quail diet significantly decreased fertility percentage. El-Latif (1999) reported that combined supplementation of vitamin E at the rate of 25 and 50 mg per kg and selenium and 1 and 2 mg per kg diet significantly (P<0.01) increased fertility percentage. Franchini *et al*. (2001) reported that vitamin E supplementation at the rate of 100 and 200 ppm in the basal diet of male broiler breeder resulted in higher sperm fertility. Shinkareva and Trifonov (2003) indicated that hens fed with supplemented selenium at the rate of 0.1, 0.2 and 0.4 mg per kg diet had positively increased fertility.

On the contrary, Cantor *et al*. (1978) observed that supplementation of selenium to the breeder diet of both turkey hens and toms had no effect on fertility percentage. Hassan (1990) also observed no significant difference in fertility percentage of White Leghorn hens supplemented with selenium in the basal diet. No literature was traceable bonding a contrary report on supplementation on Japanese quail breeders.

The increase in fertility percentage of Japanese quail might be associated with higher dietary vitamin E and organic selenium supplementation. The spermatozoa of Japanese quail contain high proportion of long chain polyunsaturated fatty acids (PUFA). These extremely high concentrations of PUFA in spermatozoa are necessary to maintain fluidity and flexibility, physical properties needed for maintenance of sperm motility as well as sperm fusion during fertilization. Such high proportions of PUFA in avian spermatozoa render them more vulnerable to lipid peroxidation, which is considered to be an important factor in male subfertility. Vitamin E and selenium containing enzyme glutathione peroxidase which play an important role in protecting spermatozoa membrane lipids from peroxidation, thus maintaining the structural integrity of the spermatozoa (Surai, 1999).

Effect of vitamin E and selenium on hatchability of Japanese quail breeder

Japanese quail fed with different levels of vitamin E and organic selenium had highly significant (P<0.01) improvement in hatchability percentage of total eggs and significant improvement (P<0.05) in hatchability percentage of fertile eggs. Dietary vitamin E and selenium significantly increased hatchability percentage, with proportionate reduction in late embryonic mortality. The Japanese quail birds in T_6 group which received combination

of vitamin E (150 mg/kg) and organic selenium (0.3 kg/mg) had significantly ($P<0.01$) increased hatchability percentage. The values of fertile hatchability for T_6 were comparable statistically with other supplemented groups and numerical reduction in early and late embryonic mortality was also observed.

Japanese quail birds fed with low vitamin E soybean meal diet severely decreased hatchability percentage (Kling and Soares, 1980). Castrovilli *et al*. (2001) reported that breeder male ration containing two per cent linseed oil with vitamin E (50 and 250 mg/kg) and vitamin C (200 mg/kg) had increased the hatchability percentage.

Supplementation of selenium at different levels significantly increased hatchability percentage as observed by Cantor and Scott (1974), Latshaw *et al*. (1977), Cantor *et al.* (1978) in turkey and Shinkareva and Trifonov (2003) in breeder hens.

Combined supplementation of vitamin E (25 and 50 mg/kg) with selenium (1 and 2 mg/kg) significantly increased the hatchability. Ganpule and Manjunatha (2003) reported that inclusion of 0.1 ppm organic selenium in combination with 75 ppm vitamin E significantly ($P<0.01$) increased hatchability percentage.

Vitamin E and selenium prevent lipid peroxidation during embryonic development and this will reduce the percentage of late embryonic mortality. Increase in hatchability percentage of Japanese quail might be associated with the higher dietary vitamin E and selenium supplementation. Developing chick embryos contain high amount of PUFA in lipid fraction increase the susceptibility to peroxidative degradation. Antioxidants protect embryos from deterimental effect of the free radicals and lipid peroxidation.

During later stage of embryonic development, the embryonic tissues contain high amount of PUFA and this will lead to lipid peroxidation. A low oxygen pressure in the environment surrounding embryos damage developing embryonic tissue. The additional levels of vitamin E and selenium to prevent lipid peroxidation and oxygen tension in embryonic tissues at hatching. The results of this study indicate that it is possible to improve reproductive characteristics of Japanese quail breeders by supplementing dietary vitamin E and selenium (selenomethione).

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Table 1 Ingredients and nutrient composition of Japanese quail diet (on drymatter basis)

Ingredient (per cent)	**Age (in weeks)**	
	Breeder Female	**Breeder male**
Maize	53.75	21.25
Pearl millet	---	40.50
Soybean meal	26.14	22.75
Deoiled groundnut cake	11.00	11.89
Dicalcium phosphate	1.66	1.66
Shell grit	7.00	1.50
Salt	0.45	0.45
	100	**100**
Supplements (g/100 kg)		
Vitamin AB_2D_3K[1]	10	10
Choline chloride 60 %[2]	100	100
Trace mineral mixture[3]	100	100
Biocare[4]	30	30
Methionine[5]	30	30

Ingredient (per cent)	**Age (in weeks)**	
	Breeder Female	**Breeder male**
Nutrients (per cent)		
Drymatter	90.72	90.25
Crude protein	19.03	19.00
ME (kcal/kg)*	2700	2700
Crude fibre	4.85	5.36
Ether extract	3.89	3.21
Calcium	3.01	1.03
Available phosphorus	0.45	0.46

Lysine*	1.02	0.96
Methionine*	0.33	0.33
Vitamin E (mg/Kg)	14.76	12.46
Selenium (mg/Kg)	0.094	0.056

Calculated values

- Manufactured by M/s. Glaxo Smithkline, Mumbai. One gram of vitamin AB2D3K supplement contained 82500 IU of vitamin A, 50 mg of vitamin B2, 12000 IU of vitamin D3 and 10 mg of vitamin K.
- Manufactured by M/s. Jubilant Organosys Ltd. Gujarat, India.
- Manufactured by M/s. Neospark Drugs and Chemicals Private Ltd., Hydrabad. One gram of trace mineral mixture contained 54 mg of manganese, 52 mg of zinc, 20 mg of iron, 2 mg of iodine and 1 mg of cobalt.
- Manufactured by M/s. Tetragon Chemie Pvt. Ltd., Bangalore. One gram biocare contained 0.4 mg of biotin.
- Manufacture by M/s. Sumitomo Chemical Company Ltd., Tokya, Japan.

Table 2 Mean (±S.E) fertility and hatchability (%) of Japanese quail eggs as influenced by Dietary supplementation of vitamin E and organic selenium

Treatment groups	Fertility (%)	Hatchability (%)		Embryonic Mortality (%)	
		Total eggs	Fertile eggs	Early (<7d)	Late (>7d)
T_1 – Control	78.01±1.10^{A}	62.62±1.14 ^{A}	80.28±1.14^{a}	9.77±1.07	7.56±0.96
T_2 –Vitamin E150 mg/kg	85.46±0.83^{B}	72.60±1.74^{B}	84.90±1.30^{b}	9.52±1.14	5.58±0.64
T_3 – Vitamin E 300 mg/kg	86.02±1.50^{B}	74.81±0.79^{B}	87.07±1.50^{b}	7.96±0.97	4.97±0.66
T_4 – Selenium 0.3 mg/kg	85.10±1.33^{B}	73.94±1.13^{B}	86.93±1.24^{b}	8.22±0.61	4.85±0.75
T_5 – Selenium 0.6 mg/kg	86.11±1.23^{B}	75.43±1.44^{B}	87.64±1.67^{b}	8.36±1.08	4.00±0.84
T_6 – Vit-E 150 mg/kg + Se 0.3 mg/kg	90.59±1.35^{C}	80.35±2.00^{C}	88.71±1.88^{b}	7.26±1.74	3.70±0.93
T_7 – Vit-E 300 mg/kg + Se 0.6 mg/kg	86.12±0.71^{B}	75.38±1.40^{B}	87.52±1.40^{b}	7.91±1.08	4.57±0.44

The value given in each cell is the mean of six observations

$^{A-D}$ Means within a column with no common superscript differ significantly (P<0.01)

$^{a-c}$ Means within a column with no common superscript differ significantly (P<0.05)