STUDIES ON PRODUCTION OF VITAMIN E AND SELENIUM ENRICHED JAPANESE QUAIL MEAT

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ABSTRACT

This study was conducted to assess the alpha- tocopherol form of vitamin E and selenium level inJapanese quailmeat. This trial was conducted in 525 Japanese quail birds fed from day- old to five weeks of age. Experimental birds were randomly divided into seven treatment 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 selenium 0.3mg/kg ; T5- Basal diet with selenium 0.6mg/kg; T6 - Basal diet with combination of Vitamin E 150mg/kg and selenium 0.3mg/kg; T7- Basal diet with combination of Vitamin E 300mg/kg and selenium 0.6mg/kg. Dietary supplementation with the combination of Vitamin E 300mg/kg and selenium 0.6mg/kg indicated significantly enriched alpha- tocopherol and selenium level in liver, thigh and breast muscles of Japanese quail meat.

Key words : Vitamin E , Selenium, Japanese quail meat, Liver, Thigh, Breast

INTRODUCTION

Vitamin E is one of the antioxidants widely used in poultry diets and has been proposed as a major antioxidant in plasma membranes of all cells and sub-cellular organs. It also functions as a chain-breaker and free radical scavenger. Poultry cannot synthesize vitamin E and its concentration is reduced under stress conditions. As dietary PUFA levels increase, the alpha-tocopherol content of organs and products decreases. The undesirable oxidative effects of n-3 PUFAs on rat erythrocytes were prevented when sufficient vitamin E was supplied (Ando *et al*., 1998). 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).

Selenium (Se) plays an important role in the antioxidant defence system due to its requirement by the Se-dependent GSHPx, which is involved in cellular antioxidant protection. It has been suggested that there is a synergistic relationship between Se and vitamin E, because GSHPx continues the work of vitamin E by detoxifying

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hydroperoxides. Recent understanding of antioxidant system functions and new discoveries regarding the GSHPx enzyme family are the basis for further development in the Se nutrition of poultry (Surai, 2002)

Selenium is found in nature in two forms, inorganic and organic. Inorganic selenium refers to different minerals such as selenite, selenate and selenide, an organic selenium is relatedto amino acids such as methionine andcysteine. Outdoor living animals that eatplants take Se in the form of selenomethionine (SeMet) (Combs and Combs, 1986) inconcentrations that depend on Se concentrationin soil, which can vary considerably according to location. Traditionally, the Se supplement in animal diets' has been in inorganic form, as sodium selenite. Recently, however, organic sources of Se have been explored as an alternative to inorganic supplementation. The amount of Se available for assimilation by the tissue is dependent on the source, and it has been shown that organic Se is deposited into the animal tissue more efficiently than inorganic Se (Choct *et al*., 2004)

Selenium and vitamin E are closely associated in metabolic antioxidant activities, and vitamin E absorption can be impaired when Se nutrition is deficient. Therefore, it is important that Se nutrition be scrutinized in order to optimize vitamin E utilization. Recent research shows Sebioavailability is influenced by form, and organic forms ofSe generally have a greater bioavailability.

MATERIALS AND METHODS

An experiment was designed to study the level of enriched vitamin E and selenium in Japanese quail meat. The experiment was conducted at the Department of Poultry Science, Veterinary College and Research Institute, Namakkal, Tamil Nadu. Namakkal is situated in northwestern agro-climatic zone of Tamil Nadu at 11.2°N and 78.2°E at an altitude of 404 meters above the Mean Sea Level. During the period of study, the average maximum and minimum temperatures of 37.56°C to 24.62°C in summer, 35.17°C and 24.10°C in rainy and 32.50°C and 21.72°C in winter respectively were recorded. Mean relative humidity throughout the study period ranged from 52.25 to 76.42 per cent.

The biological experiment was conducted in five weeks duration. The experiment was started using five hundred and twenty five nos. of day-old Japanese quail chicks. The day old Japanese quail chicks were individuallyweighed, wing banded and randomly allotted to seven treatment groups with three replicates of twenty-five chicks each.

Feed ingredients used for formulation of diets were analysed for vitamin E and selenium content in addition to proximate composition. The quail diets were formulated as per the standard method prescribed by Shrivastav and Panda (1999), Central Avian Research Institute, Izatnagar to which vitamin E and selenium level is added. Vitamin E in the form of dl-α-tocopheryl acetate, 50 per cent (Promix E, Addisseo company) and 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 diets.

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 selenium 0.3mg/kg; T5- Basal diet with selenium 0.6mg/kg;T6-Basal diet with combination of Vitamin E 150mg/kg and selenium 0.3mg/kg ; T7 - Basal diet with combination of Vitamin E 300mg/kg and selenium 0.6mg/kg.

The Japanese quail chicks of all treatment groups were reared in cages under standard managemental conditions throughout the experimental period. The Japanese quailwere fed with respective quail brooder or grower ration*ad* *libitum* and had free access to wholesome potable water throughout the experimental period.

The ingredients and nutrient composition of quail chick diet (0-2 weeks) and grower diet (3-5 weeks) are presented in Table 1.

During the first phase of biological experiment individual body weight and total feed consumption in each treatment group were recorded at weekly intervals. Based on these data, weekly body weight gain and feed efficiency were calculated. The mortality of quail was recorded on its occurrence during the experimental period and the livability percentage was worked out.

At the end of five weeks growth period, six birds (three males and three females) from each experimental group were selected randomly and subjected to humane method of slaughter. The muscles of breast and thigh and liver were collected from all the slaughtered quail and analysed for α-tocopherol level by using HPLC system procedure as described by Surai (2000) and selenium by flourometric method procedure as described by AOAC (2000).

All the parameters data obtained in this study were subjected to analysis of completely randomised design (CRD) for statistical significance as per the methods outlined by Snedecor and Cochran, (1994).

RESULTS AND DISCUSSION

Body weight and Feed Efficiency

The effects of dietary Vitamin E and Selenium supplementation on Japanese quails on body weight and feed efficiency from day- old to five weeks are presented in table2 and table 3.

The present study indicated significant improvement in body weight gain in Japanese quails supplemented with vitamin E 300 mg/kg and selenium 0.6 mg/kg. These findings are in agreement with the earlier reports of Sahin *et al.* (2003) in Japanese quail, Swain *et al*. (2000) and Aravind *et al*. (2001) in broilers.Significant increase in body weight gain was also observed by Sahin *etal*. (2003) with vitamin E supplementation at 250 mg per kg in Japanese quail raised under high ambient temperature of 33°C.Increased body weight gain with selenium supplementationin White Leghorn chicks was reported by Osman and Latshaw (1976) and Yu-Ping Zhou and Combs (1984) and Georgievsi *et al.* (1985) and Bonomi (2001) reported the same in broilers.

The improvement in body weight gain of vitamin E and selenium supplemented group might be due to vitamin E as an excellent biological chain breaking antioxidant that protects cells and tissues from lipoperoxidative damage induced by free radicals. Vitamin E interacts with selenium containing enzyme glutathione peroxidase to prevent the oxidative breakdown of tissue membranes and cell membrane damage (Surai 2000).

The present study revealed that supplementation of vitamin E 300 mg/kg and selenium 0.6 mg/kg in Japanese quail resulted in significant ($P<0.01$) improvement in feed efficiency among treatment groups during first to fifth week of age.

Kennedy *et al*. (1991), Barreto *et al*. (1999) and Guo YuMing *et al*. (2003) reported improvement in feed efficiency of broilers due to dietary vitamin E supplementation. Yu-Ping Zhou and Combs (1984), Edens *et al.* (2000) indicated that dietary selenium supplementation significantly improved the feed conversion ratio of broilers. Combined supplementation of vitamin E (250 IU/kg) and organic selenium (0.3 ppm) in broilers had resulted in significant reduction in feed conversion ratio (Roch *et al*., 2000), which is in agreement with the results of this study. However, Bartov and Frigg (1992), Menocal *et al*. (1998) and

Nageshwara *et al.* (2003) observed no significant difference in feed efficiency.

The improvement in growth and feed efficiency by vitamin E and selenium supplementation might be due to the possible removal of free radicals. Free radicals are scavenged by vitamin E and selenium containing enzyme glutathione peroxidase, which destroys the peroxides formed, that can damage the cell. These two antioxidants protect cell membranes against oxidative damage and also improve the utilization of nutrients.

Alpha–tocopherol level in liver and meat

The mean α-tocopherol level (μg/g) in liver, thigh and breast muscle of five weeks old Japanese quail as influenced by supplementing vitamin E and selenium in the basal diet are presented in Table 4.

The α-tocopherol level in liver, thigh and breast was higher in combination of vitamin E (300 mg/kg) and selenium (0.6 mg/kg) supplemented group (T_7) and then followed by vitamin E at 300 mg per kg diet alone fed group (T_5).

The effect of different levels of vitamin E and selenium supplementation in Japanese quail significantly (P<0.01) increased the level of α-tocopherol in liver, thigh and breast of Japanese quail. The α-tocopherol level in liver, thigh and breast was higher in combination of vitamin E (300 mg/kg) and selenium (0.6 mg/kg) supplemented group (T_7) and then followed by vitamin E at 300 mg per kg diet alone fed group (T_5). The level of α-tocopherol registered a 6.9 and 6.3 fold increase in liver of birds in T_7 and T_3 respectively. In thigh it was 6.8 and 6.5 and in breast it was 7.2 and 6.6 in T_7 and T_3 groups, respectively. The level of α-tocopherol in liver, thigh and breast of Japanese quail mainly depends on the amount of dietary supplementation. Higher dietary vitamin E supplementation significantly increased the level of α-tocopherol in tissues in a dose dependent manner.

Mlodkowski *et al*. (2003) and Carreras *et al*. (2004) concluded that graded levels of vitamin E supplementation significantly increased the α-tocopherol level in organ and tissues, which is in accordance with the results of this study.The increased α-tocopherol level in liver, thigh and breast of Japanese quail might be due to more absorption of -tocopherol from the intestine. Dietary α-tocopherol supplementation increased the amount of α-tocopherol absorbed through the intestines, transported in the blood and deposited in the tissues.

In general the present study revealed that the Japanese quail fed with vitamin E 300 mg/kg and selenium 0.6 mg/kg supplementation in feed showed higher α-tocopherol level in liver, thigh and breast compared to other treatment groups and control.

Selenium level in liver and meat

The mean selenium level (ng/g) in liver, thigh and breast muscle of Japanese quail as influenced by supplementing vitamin E and selenium in the basal diet are presented in Table 4.

Different levels of vitamin E and selenium supplementation in basal diet significantly (P<0.01) increased selenium level in liver, thigh and breast of Japanese quail. The highest level of selenium in liver, thigh and breast was noticed in combination of vitamin E (300 mg/kg) and selenium (0.6 mg/kg) supplemented group (T_7) followed by selenium (0.6 mg/kg) alone fed group (T_5). The increase in selenium concentration in liver, thigh and breast of Japanese quail which received both vitamin E 300 mg per kg and selenium 0.6 mg per kg (T_7) was 5, 3.86, 4.98 times respectively as that of control group.Similar findings were observed by Karadas *et al*. (2004) in Japanese quail, Hassan(1990) in White Leghorn chicks and Kuricova *et al*. (2003) in laying strain of ISA brown.

In general, the present study revealed that the Japanese quail received vitamin E 300 mg/kg and selenium 0.6 mg/kg in feed showed higher selenium level (ng/g) in liver, thigh and breast compared to other treatment groups and control.

The selenium and alpha-tocopherol contents of breast and thigh meat in broilers were significantly increased by organic dietary selenium and vitamin E supplementation. The inclusion of organic dietary Se sources in the diets of laying hens and broilers would enhance the nutritional value (vitamin E and Se contents) of products (eggs and meat) for human consumption.

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Table 1.Ingredients and nutrient composition of experimental Japanese quail diet(on DM basis)

Ingredient(per cent)	Age (in weeks)	
	Chick (0-2)	Grower (3-5)
Maize	44.60	46.35
Pearl millet	---	---
Soybean meal	29.00	34.50
Deoiled groundnut cake	24.00	17.24
Dicalcium phosphate	0.45	0.58
Shell grit	1.50	0.88
Salt	0.45	0.45
	100	**100**
Supplements (g/100 kg)		
Vitamin AB_2D_3K[1]	20	10
Choline chloride 60 %[2]	200	200
Trace mineral mixture[3]	100	100
Biocare[4]	---	---
Methionine[5]	80	80

Ingredient(per cent)	Age (in weeks)	
	Chick 0-2	Grower 3-5
Nutrients (per cent)		
Drymatter	91.52	91.20
Crude protein	27.00	24.00
ME (kcal/kg)*	2814	2800
Crude fibre	6.24	6.02
Ether extract	3.46	3.28
Calcium	0.80	0.60
Available phosphorus	0.30	0.30
Lysine*	1.26	1.20
Methionine*	0.48	0.45
Vitamin E (mg/Kg)	14.60	13.45
Selenium (mg/Kg)	0.076	0.089

Calculated values

1. Manufactured by M/s. Glaxo Smithkline, Mumbai. One gram of vitamin AB_2D_3K supplement contained 82500 IU of vitamin A, 50 mg of vitamin B_2, 12000 IU of vitamin D_3 and 10 mg of vitamin K.
2. Manufactured by M/s. Jubilant Organosys Ltd. Gujarat, India.
3. 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.
4. Manufactured by M/s. Tetragon Chemie Pvt. Ltd., Bangalore. One gram biocare contained 0.4 mg of biotin.
5. Manufactured by M/s. Sumitomo Chemical Company Ltd., Tokya, Japan.

Table 2: Mean body weight gain (g) of Japanese quail as influenced by supplementingvitamin E and / or seleniumfrom Day-old to 5 weeks of age

Treatment groups	I Week	II Week	III Week	IV Week	V Week
T_1 – Control	20.58 ± 0.28^{A}	61.33± 0.70^{A}	119.22± 1.35^{A}	177.22±1.62^{A}	215.22±1.63^{A}
T_2 –Vitamin E150 mg/kg	23.38± 0.50^{BC}	64.15± 0.85^{ABC}	125.07±1.39^{CD}	182.62±1.40^{BC}	223.17±1.72^{BCD}
T_3 – Vitamin E 300 mg/kg	24.33 ± 0.53^{CD}	64.72± 0.93^{BCD}	126. 25±1.42^{CD}	185.47±1.43^{CD}	225.92±1.83^{CDE}
T_4 – Selenium 0.3 mg/kg	21.90 ± 0.27^{AB}	62.62± 0.89^{AB}	119. 57±1.20^{AB}	178.60±1.48^{AB}	218.95±1.80^{AB}
T_5 – Selenium 0.6 mg/kg	23.25 ± 0.50^{BC}	63.47± 0.90^{AB}	121.56±1.64^{ABC}	179.99±1.48^{AB}	221.07±1.64^{ABC}
T_6 – Vit-E 150 mg/kg + Se 0.3 mg/kg	24. 51 ± 0.55^{CD}	67.71± 0.89^{D}	127.14±1.68^{D}	188.58±1.36^{D}	230.15±1.60^{E}
T_7 – Vit-E 300 mg/kg + Se 0.6 mg/kg	25.33 ± 0.61^{D}	66.67± 0.76^{CD}	126.20±1.65^{CD}	187.75±1.35^{CD}	228.20±1.74^{DE}

The value given in each cell is the mean of seventy-five observations

$^{A-E}$ Means within a column bearing at least one common letter superscript do not differ significantly (P<0.01)

Table 3: Mean feed efficiency of Japanese quail as influenced by supplementingvitamin E and / or selenium from Day- old to 5 weeks of age

Treatment groups	I Week	II Week	III Week	IV Week	V Week
T_1 – Control	1.78±0.01^{C}	2.07±0.02^{C}	2.26±0.06^{b}	2.42±0.03^{c}	2.86±0.03^{D}
T_2 –Vitamin E150 mg/kg	1.54±0.05^{AB}	1.96±0.05^{ABC}	2.14±0.03^{a}	2.34±0.04^{c}	2.74±0.02^{BC}
T_3 – Vitamin E 300 mg/kg	1.49±0.03^{AB}	1.93±0.02^{AB}	2.110.01^{a}	2.29±0.03^{AB}	2.700.01^{AB}
T_4 – Selenium 0.3 mg/kg	1.62±0.03^{BC}	2.01±0.03^{BC}	2.240.01^{b}	2.39±0.02^{B}	2.800.03^{CD}
T_5 – Selenium 0.6 mg/kg	1.55±0.03^{AB}	1.98±0.04^{BC}	2.200.03^{ab}	2.36±0.02^{ABC}	2.77±0.01^{BC}
T_6 – Vit-E 150 mg/kg + Se 0.3 mg/kg	1.45±0.08^{A}	1.84±0.02^{A}	2.10±0.07^{a}	2.25±0.03^{A}	2.65±0.02^{A}
T_7 – Vit-E 300 mg/kg + Se 0.6 mg/kg	1.45±0.01^{A}	1.89±0.04^{AB}	2.12±0.01^{a}	2.27±0.01^{A}	2.69±0.02^{AB}

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

$^{A-D}$ Means within a column bearing one common letter superscript do not differ significantly (P<0.01)

$^{a-b}$ Means within a column bearing one common letter superscript do ot differ significantly (P<0.05)

Table 4: Mean alpha-tocopherol level (µg/g) and selenium level (ng/g) in Japanese quail liver and meat as influenced by supplementingvitamin E and / or selenium.

Treatment groups	Liver		Thigh		Breast	
	α-tocopherol	selenium	α-tocopherol	selenium	α-tocopherol	selenium
T_1 – Control	54.17 ± 1.02^{A}	63.40 ± 0.65^{A}	9.47 ± 0.38^{A}	35.63 ± 1.41^{A}	4.28 ± 0.44^{A}	21.51 ± 0.91^{A}
T_2 –Vitamin E150 mg/kg	224.64 ± 1.38^{D}	75.28 ± 0.90^{B}	37.69 ± 0.44^{D}	39.95 ± 1.46^{AB}	19.89 ± 0.64^{C}	26.60 ± 1.05^{AB}
T_3 – Vitamin E 300 mg/kg	358.44 ± 2.12^{F}	83.26 ± 1.13^{C}	61.90 ± 0.55^{F}	42.78 ± 1.28^{BC}	28.39 ± 1.08^{D}	27.23 ± 0.87^{BC}
T_4 – Selenium 0.3 mg/kg	72.77 ± 1.32^{B}	186.09 ± 1.43^{D}	16.40 ± 0.79^{B}	87.26 ± 1.07^{D}	8.93 ± 0.19^{B}	74.10 ± 2.60^{D}
T_5 – Selenium 0.6 mg/kg	85.04 ± 1.24^{C}	316.36 ± 1.34^{E}	19.79 ± 0.86^{C}	136.59 ± 1.32^{E}	10.21 ± 0.21^{B}	106.23 ± 1.45^{E}
T_6 – Vit-E 150 mg/kg + Se 0.3 mg/kg	242.37 ± 1.70^{E}	190.56 ± 1.18^{D}	45.53 ± 1.12^{E}	90.14 ± 1.65^{D}	22.13 ± 0.45^{c}	76.20 ± 1.83^{D}
T_7 – Vit-E 300 mg/kg + Se 0.6 mg/kg	372.49 ± 1.16^{G}	317.35 ± 1.36^{E}	64.90 ± 1.27^{F}	137.80 ± 1.73^{E}	30.83 ± 0.47^{D}	107.32 ± 1.35^{E}

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

$^{A-G}$ Means within a column bearing at least one common letter superscript do not differ significantly (P<0.01)