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Effect of Supplementation of Different Levels and Combinations Of Selenium And Vitamin E on Broiler Chicken Performance, Immune Response, Meat Selenium And Vitamin E Concentration.

K. Sridhar *, N. Nalini Kumari, J. Narasimha, Arun Kumar Panda and K.Sushma
Department of Animal Nutrition, College of Veterinary Science, Rajendranagar, Hyderabad, Telangana, 500030, India
*Correspondence: drsushmajayachandra@gmail.com

ABSTRACT

In present experiment, 210,one day old commercial broiler chicks (42 replicates with 5 chicks in each) were randomly allotted to 6 treatments (2×3 factorial design) to investigate the effect of different combinations of selenium (Se) (0.15 or 0.3 mg/kg) and vitamin E (VE) (50, 100 or 200 mg/kg diet) on performance, immune response, and Se and VE deposition in the meat. Birds' performance, carcass traits (42 d) and humoral immune response (antibody titres against Newcastle disease vaccine) (on day 35) were comparable among the dietary treatments. Increased Se supplementation, improved (P<0.01) the relative weight of bursa. Higher dietary Se and VE levels improved (P<0.01) the cell mediated immune response (against phytohemagglutinin-P) on day 40. Se deposition in breast and thigh meat and VE in thigh meat was increased (P<0.01) with higher levels of Se (0.30 mg/kg) and VE (200 mg/kg) supplementation. The VE deposition was increased (P<0.01) in breast meat with increased VE supplementation. It can be concluded that, broiler chicken meat can be enriched with inclusion of 0.30 mg/kg Se and 200 mg/kg VE in broilers diet without affecting bird's performance. Further, immune response of birds was improved due to supplementation of higher levels of Se and VE.

KEYWORDS: Broiler chicken, immune response, performance, selenium, vitamin E.

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INTRODUCTION

The results of recent research suggest that, dietary and lifestyle factors contribute to the development of many non-infectious diseases, including obesity, cardiovascular and degenerative diseases (Bosma-den Boer et al., 2012; Chakma et al., 2014). Furthermore, in current competitive, the work has become more technological, strenuous, involves limited physical activity and odd working hours,all these conditions, cumulatively inducing more stress resulting in free radical associated diseases (Bosma -den Boer et al., 2012; Chakma et al., 2014). The risk of diseases due to oxidative stress is also associated with unhealthy lifestyle, like exposure to chemicals, pollution, drugs, cigarette smoking, etc. It is well proved thatselenium (Se) and vitamin E (VE) are essential antioxidants in human diet to counteract the free radical associated diseases; and improve the immunity and health, furthermore, the high levels of Se and VE may give additional protection against some diseases(Lobo et al., 2010;Jiang,2014). In addition to this, Se andVE are interrelated and they spare each other and show better antioxidant activity (McDowell, 2002).

The common approach to combat these dietary/ lifestyle related disorders involves consumption of pharmaceutical drugs which makes consumers feel psychologically sick. Hence, consumers are now looking for food products that provide value beyond nutrition (Bigliardi and Galati, 2013). To overcome these problem, the present study targets in developing functional foods (Se and VE enriched meat), which can be consumed as food, not as capsules. The main concept of it is "Let food be the medicine and not medicine be the food" as suggested by Hippocrates 2500 years ago. Functional foods are defined as "foods that may provide health benefits beyond basic nutrition".

The chicken meat is most commonly consumed meat source in India and across the world due to its affordability and perceived health benefits such as low in cholesterol, and fat and rich in protein and other micronutrients compared to other meats (Bhalerao et al., 2013). The nutritional profile of chicken meat could be further improved or modified easily by addition of potentially health promoting nutrients to their diets (Bhalerao et al., 2013). Increasing essential nutrient in broiler chicken diet not only increase desired nutrients in the meat, but also may show beneficial effect on bird's performance and health. Thus, the proposed study is aimed to enrich the chicken meat with Se and VEthrough nutritional manipulation using different combinations of Se and VE and their influence on the birds' performance and immune response.

MATERIAL AND METHODS

Two hundred and ten day old commercial (Vencobb) broiler chicks were randomly allotted to 42 replicates with 5 chicks in each. As per NRC, 1994 a factorial design (2x3) was used to study the effect of different dietary levels of Se (0.15 or 0.3 mg/kg; as organic Se), vitamin E (50, 100 or 200 mg/kg diet) and their interaction. Corn-soybean meal based basal diet (BD) was prepared to meet the nutritional requirements of birds, except Se and vitamin E (VE). Further, experimental diets were formulated by addition of premix with different levels of Se and VE to the BD as mentioned below

Table 1. .Different levels of Se and VE to the Basal Diet

S.NO	Diet	Se (mg/kg diet)	Vitamin E (mg/kg diet)
1	$Se_{0.15}VE_{50}$	0.15	50
2	$Se_{0.15}VE_{100}$	0.15	100
3	$Se_{0.15}VE_{200}$	0.15	200
4	$Se_{0.30}VE_{50}$	0.30	50
5	$Se_{0.30}VE_{100}$	0.30	100
6	$Se_{0.30}VE_{200}$	0.30	200

Selenium used in the present investigation was organic Se (Sel-Plex, Se enriched yeast, Alltech) and the amount of Se in this source was 20%. The vitamin E used in this study was Lutavit-50 (BASF South East Asia PTE Ltd) and contained 50% vitamin E acetate.

Birds were reared on raised wire floor battery brooder in open side houses. The brooder temperature was maintained at $34 \pm 1^{O}C$ up to 7 days of age and gradually reduced to $26 \pm 1^{O}C$ by 21 days of age after which, chicks were maintained at room temperature. All the replicate groups of chicks were offered the respective diets *ad libitum*. Uniform management and vaccination schedule were followed for all the birds.

Individual body weight of chicks and replicate-wise feed intake were recorded at weekly interval.Feed conversion ratio (FCR) was calculated as the ratio between feed consumed (g) and weight gained (g).On day 43, six birds from each dietary treatment were selected randomly and feed was withdrawn for 12 h and the same birds were slaughtered by cervical dislocation to study the carcass traits. The parameters studied were total carcass yield, breast yield and individual organ weights like liver, heart, gizzard, abdominal fat, spleen and bursa. Meanwhile representative samples of thigh and breast meat samples were collected and stored at $-20^{o}C$ for further estimation of Se and VE.

Blood was collected from one bird of each replicate on day 35 from brachial vein of birds and serum was separated and stored at $-20^{o}C$ for measuringhumoral immune response.While collection of blood, a thin layer of blood smear was prepared with drop of fresh blood on a glass slide. Afterwards, those slides were stained with Geimsa stain to study the heterophils to lymphocyte ratio under compound microscope (100X; oil immersion).

The humoral immunity was estimated in birds by measuring antibody titer to Newcastle disease (ND) vaccine (antibody production against ND virus).Broilers were vaccinated against ND by ocular route at 7th and 21stday of age with Lasota strain (ND Lasota Vac-500; Indivax Pvt., Ltd., Hyderabad, India). At 35 days of age, blood was collected and serum was separated. Subsequently, micro-hemagglutination activity of serum was estimated and the antibody titers (log_2) were measured following the standard procedure (Wegmann and Smithies, 1966).

On 40th day of experiment, the cell mediated immune response (CMIR) was assessed in one bird of each replicate by measuring *in vivo* cutaneous basophilic hypersensitivity to phytohemagglutinin phosphate (PHA-P).The response was determined by inter-digital foot web reaction against PHA-P (100 µg), as the procedure prescribed by Corrier and Deloach (1990).

The stored meat samples in deep freezer were thawed to room temperature. Approximately 1 g of sample was wet digested by diacid method in which, samples were kept for overnight with 10 ml of concentrated HNO_3 and next day those samples were digested with 10 ml HNO_3 and 2-3 ml perchloric acid on hot plate at 180-200^{o}C till the dense white colour fumes appeared. Further, it was transferred to a 50ml volumetric flask by several washings with double distilled water through Whatman filter paper No.42 and final volume was made to 50ml. These processed samples were analysedusing Atomic Absorption Spectrophotometer (Perkin Elmer A Analyst 100).

Approximately 3.0 g of thawed meat sample (free from connective tissue) was homogenized with twice volume of methanol and transferred to round bottom flask. 30ml methanol was added to round bottom flask and shook well. Further 3 ml of 10% ascorbic acid and 4 ml of 50% KOH were added to round bottom flask and sonicated this mixture for 10 min and saponified under reflux for 3 hours in dark. The saponified contents were cooled to room temperature and transferred into separating funnel with repeated washing using distilled water. This saponified solution was extracted thrice with petroleum benzene (70, 40 and 40 ml). The extract was washed repeatedly with distilled water (100 ml each time) till the washings were neutral to phenolphthalein. Finally, the extracted layer was passed through anhydrous sodium sulphate to make it free from moisture and collected in beaker. The collected extract was dried on rotor evaporator. After that residue was dissolved in 10 ml methanol and estimated the VE using HPLC (Shimadzu, LC 2010 A). Similar procedure followed for standards preparation. Aliquot (20 µl) was injected into a hypersil (ODS c18, 4.6 x 250mm, 5Um) column with 100% methanol (HPLC grade) as mobile phase and run for 15 min, further, the concentration was detected at 248 nm using UV-VIS detector. Final concentration was calculated using below formulae.

Concentration of vitamin = (Sample concentration from the calibration curve × sample made×sample dilution×purity of standard)×100/ Weight of sample).

The statistical analysis was carried out using statistical package for social sciences (SPSS) 16th version. The obtained data in trial was subjected to two-way ANOVA to study the individual effect (Se or VE) and their interactions (Se Vs VE). When the two-way ANOVA found to be significant for treatment effects (interaction effect), means were separated using one-way ANOVA. The differences between the means were tested for significance using Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

The results of the present study showed that body weight gain (BWG), feed intake (FI) and feed conversion ratio (FCR) of broiler chicks were not influenced (P>0.05) due to supplementation of different levels of Se (0.15 to 0.30 mg/kg), VE (50, 100 or 200 mg/kg diet) or their various combinations (2×3 factorial design) (Table 2).

Table 2. Ingredient and nutrient composition of basal diet (%)

Ingredient	Starter (0-3 wk)	Finisher (4-6wk)
Maize	57.80	61.50
Soybean meal	34.20	30.00
Oil	3.27	3.88
Stone grit	1.60	1.85
DCP	1.90	1.65
Salt	0.40	0.40
DL- Methionine	0.19	0.16
Lysine	0.14	0.06
Vitamin premix[1]	0.05	0.05
Mineral premix[2]	0.10	0.10
Coccidiostat	0.05	0.05
Antibiotic	0.05	0.05
Choline	0.10	0.10
Tylosine	0.05	0.05
Toxin binder	0.10	0.10
Total	100	100
Nutrient composition[#]		
ME (Kcal/kg)	3050	3154
Crude protein (%)	21.5	19.53
Crude fiber (%)	3.32	3.12
Calcium (%)	1.0	1.0
Available phosphorus (%)	0.45	0.4
Lysine (%)	1.2	1.0
Methionine (%)	0.5	0.45

[1]Vitamin premix provided per kg diet: Vitamin A, 20000IU; Vitamin $D_{3,}$ 3000IU; Vitamin K, 2mg; Riboflavin, 25mg; Vitamin$B_{1,}$ 1mg; Vitamin $B_{6,}$ 2mg; Vitamin $B_{12,}$ 40mcg and Niacin, 15 mg

[#] On dry matter basis and calculated values

[2]Trace mineral provided per kg diet: Cu, 8mg; Fe, 80mg; Zn, 40mg and Mn 60 mg

Further experimental diets were formulated by adding various levels of Se (0.15 or 0.30 mg/kg diet) and vitamin E (50, 100 or 200 mg/kg) to this BD as mentioned above

Rama Rao et al. (2013) reported that, 0.1 mg/kg Se supplementation as Se-methionine is optimum to maintain the broiler chicks' performance (BWG, FI and FCR). The authors observed no significant (P>0.05) influence of higher levels (0.2, 0.3 and 0.4 mg/kg) of Se supplementation on birds performance. In another study, Panda et al.(2009) observed optimum broilers performance due to 30 mg VE supplementation per kg diet, and they noticed no further improvement (P>0.05) in birds performance

with higher dietary VE concentration (150 or 300 mg/kg diet). In the current investigation, birds fed on diets supplemented with minimum of 0.15 mg/kg Se and 50 mg/kg VE elicited optimum performance.In agreement with results of the current study, several researchersobserved no significant difference in BWG, FI and FCR in broilers fed on diet supplemented with different levels of VE (Coetzee and Hoffman,2001;Niu et al.,2009) or Se (Niu et al., 2009;Chen et al., 2013;Celi et al.,2014,Gružauskas et al.,2014). Similarly, Tayeb and Qader (2012) observed comparable BWG, FI and FCR among the broilers supplemented with different levels of Se (0.15, 0.3 or 0.45 mg/kg) and VE (100 or 150 mg/kg diet) and their different combinations (3×2 factorial design).

Birds supplemented with different levels of Se and VE or their various combinations had no significant influence on dressing yield, breast yield, abdominal fat and relative weight of visceral organs *viz*., liver, heart, gizzard (as % of live weight) (Table 3).

Table 3. Effect of different levels of Se and vitamin E supplementation on performance of broiler chickens

Treatment		Body weight gain (g)			Feed intake (g)			Feed conversion ratio		
Se (mg/kg)	Vitamin E (mg/kg)	Starter (0-3wk)	Finisher (4-6wk)	Total (0-6wk)	Starter (0-3wk)	Finisher (4-6wk)	Total (0-6wk)	Starter (0-3wk)	Finisher (4-6wk)	Total (0-6wk)
	50	518	1421	1939	643	2,426	3,069	1.24	1.71	1.58
0.15	100	494	1402	1896	643	2,393	3,036	1.31	1.71	1.60
	200	511	1424	1934	654	2,431	3,086	1.28	1.71	1.60
	50	499	1380	1878	647	2,399	3,046	1.30	1.74	1.62
0.30	100	508	1407	1915	651	2,347	2,998	1.28	1.67	1.57
	200	502	1372	1874	653	2,364	3,017	1.30	1.72	1.61
Selenium										
0.15		508	1416	1923	647	2,417	3,064	1.28	1.71	1.59
0.30		503	1386	1889	650	2,370	3,021	1.30	1.71	1.60
Vitamin E								.		
50		508	1401	1909	645	2,413	3,058	1.27	1.73	1.60
100		501	1405	1905	647	2,370	3,017	1.29	1.69	1.58
200		506	1398	1904	654	2,398	3,051	1.29	1.72	1.60
Pooled SEM		4.95	14.27	17.68	4.24	23.22	25.33	0.01	0.01	0.01
P value										
Se		0.63	0.31	0.34	0.67	0.32	0.40	0.31	0.98	0.77
Vitamin E		0.82	0.98	0.99	0.70	0.75	0.78	0.54	0.44	0.63
Se × vitamin E		0.38	0.69	0.57	0.90	0.94	0.93	0.23	0.48	0.25

SEM: Standard error of mean

Similarly, Rama Rao et al. (2013) observed no significant effectof increased dietary Se (0, 0.1, 0.2, 0.3 and 0.4 mg/kg) concentration on the carcass traits (ready to cook yield, relative weight of liver, heart and giblet) of broiler chickens. Further, carcass yield of broilers was not influenced with increased Se (0.0, 0.3, 0.5, 1.0 and 2.0 mg/kg) supplementation (Chen et al., 2013). Tayeb and Qader (2012)report was in agreement with the current findings that, dietary addition of different levels of Se (0.15, 0.3 or 0.45 mg/kg), vitamin E (100 or 150 mg/kg diet) and their various combinations (3×2 factorial design) had no

significant influence on carcass weight, dressing percentage, yield of breast and thigh meat and abdominal fat percentage of broilers.

Supplementation of different levels of Se (0.15 or 0.30 mg/kg), VE (50, 100 or 200 mg/kg) and their various combinations had no influence (P>0.05) on HIR. Similarly, HL ratio was not influenced (P>0.05) by either level of Se and VE or their interaction. The relative weight of spleen was not influenced (P>0.05) by dietary treatments, however, relative bursa weight (primary lymphoid organ), which is an indication of better immune response (Cooper et al., 1966)was significantly (P<0.01) increased with increased Se content (0.15 to 0.30 mg/kg) in diet, but relative bursa weight was not influenced by dietary VE concentration (50, 100 or 200 mg/kg) and its interaction with Se (Table 4).

Table 4. Effect of different levels of Se and vitamin E supplementation on carcass traits (% of live weight) of broiler chickens

Treatment		Dressed yield	Breast yield	Visceral organs			Abdominal fat
				Liver	Heart	Gizzard	
Se (mg/kg)	Vitamin E (mg/kg)						
	50	70.42	20.59	1.68	0.45	1.86	0.93
0.15	100	68.38	21.03	1.72	0.45	1.96	1.32
	200	68.20	19.72	1.64	0.41	1.90	1.13
	50	67.54	19.13	1.61	0.51	2.12	1.24
0.30	100	68.18	21.39	1.60	0.45	1.99	1.11
	200	67.40	20.57	1.74	0.48	1.93	1.24
Se (mg/kg)							
0.15		69.00	20.45	1.68	0.54	1.91	1.13
0.30		67.71	20.36	1.65	0.48	2.01	1.20
Vitamin E (mg/kg)							
50		68.98	19.86	1.65	0.48	1.99	1.08
100		68.28	21.21	1.66	0.45	1.98	1.21
200		67.80	20.14	1.69	0.59	1.91	1.18
Pooled SEM		0.23	0.24	0.03	0.04	0.03	0.06
P value							
Se		0.72	0.87	0.58	0.42	0.07	0.55
Vitamin E		0.12	0.07	0.85	0.23	0.47	0.64
Se × vitamin E		0.53	0.14	0.26	0.22	0.17	0.21

SEM: Standard error of mean

In agreement with current findings, Rama Rao et al.(2013)observed no affect (P>0.05) of increased dietary Se (0, 0.1, 0.2, 0.3 and 0.4 mg/kg) concentration on HIR (antibody titre against ND vaccine), HL ratio. Similarly, Chen et al.(2013) found no influence of dietary Se concentration (0.0, 0.3, 0.5, 1.0 and 2.0 mg/kg) on immune organ index (bursa and spleen) in broilers. Inconsistent with present findings, no significant difference in HIR was observed in broilers supplemented with either 100 or 200 mg/kg of VE(14). On other hand Panda et al.(2009) observed higher (P<0.05) HIR (titres against ND vaccine) in broilers supplemented with 150 or 300 mg/kg diet VE compared to birds

supplemented with 10 or 30 IU VE/kg diet. Tayeb and Qader (2012) also observed no effect of different levels of dietary Se (0.15, 0.3 or 0.45 mg/kg), vitamin E (100 or 150 mg/kg diet) and their combinations (3 ×2 factorial design) on HL ratio. On contrary, Yamuna and Thangavel (2011) noticed significantly ($P<0.05$) higher antibody titres against SRBC (HIR) due to increased Se (0.1, 0.3 or 0.5 mg/kg) and VE (10, 20 or 30 mg/kg) supplementation to broilers, in addition, they observed interaction effect of Se and VE on HIR.

Cell mediated immune response (CMIR) (response against PHA-P) was improved ($P<0.01$) in birds with increased Se or VE supplementation but no significant effect of Se and VE interaction was observed on CMIR. Birds fed diet supplemented with 0.30 mg/kg had shown higher CMIR compared to those supplemented with 0.15 mg/kg Se. Higher ($P<0.01$) CMIR was observed in 200 mg/kg VE supplemented group compared to 50 or 100 mg/kg VE supplemented groups, in which CMIR was statically comparable ($VE_{50}=VE_{100}<VE_{200}$). Higher doses of Se or VE supplementation improved the immunity in chicks might have by down regulating the oxidation (Marsh et al., 1981). Similarly, Rama Rao et al. (2013) observed improvement in CMIR (lymphocyte proliferation) of broilers with increased dietary Se concentration (0, 0.1, 0.2, 0.3 and 0.4 mg/kg). On other hand Chen *et al.*(2013)found no influence ($P>0.05$) of dietary Se concentration (0.0, 0.3, 0.5, 1.0 and 2.0 mg/kg) on CMI (on day 42) in broilers. Similar to present findings, Panda et al.(2009)also observed higher ($P<0.05$) CMIR (response against PHA-P) in broiler supplemented with 150 or 300 mg/kg diet VE compared to birds supplemented with 10 or 30 IU VE/kg diet. On contrary, no significant difference in CMIR was observed in broilers with supplementation of either 100 or 200 mg/kg of VE (Niu et al., 2009).

The effect of dietary inclusion of different levels of Se and VE on Se and VE deposition in meat is presented in Table 5.

Table 5. Effect of different levels of Se and vitamin E supplementation on humoral, cell mediated immune responses, relative weights of immune organs and H:L ratio

Treatment		ND titer (log_2)	PHA-P response	Spleen	Bursa	H:L ratio
Se (mg/kg)	Vitamin E (mg/kg)					
	50	6.50	0.64	0.11	0.13	0.35
0.15	100	6.83	0.87	0.11	0.13	0.38
	200	7.17	1.04	0.11	0.15	0.37
	50	6.83	0.99	0.12	0.20	0.35
0.30	100	7.17	1.04	0.11	0.18	0.37
	200	7.33	1.27	0.14	0.19	0.36
Se (mg/kg)						
0.15		6.83	0.85^{b}	0.11	0.14^{b}	0.33
0.30		7.11	1.10^{a}	0.12	0.19^{a}	0.36
Vitamin E (mg/kg)						
50		6.67	0.82^{b}	0.11	0.16	0.35
100		7.00	0.96^{b}	0.11	0.15	0.37
200		7.25	1.15^{a}	0.12	0.17	0.37
Pooled SEM		0.19	0.03	0.01	0.01	0.02
P value						
Se		0.47	0.01	0.39	0.01	0.99
Vitamin E		0.46	0.01	0.77	0.69	0.83
Se × vitamin E		0.98	0.49	0.76	0.55	0.94

[abc]Means with different superscripts in a column differ significantly; ND: Newcastle disease; PHA-P: Phytohemagglutinin-p; H:L: Heterophils to lymphocytes; SEM: Standard error of mean

Table 6. Effect of different levels of Se and vitamin E supplementation on Se and Vitamin E content in meat

Treatment		Se (µg/kg meat)		Vitamin E (mg/kg meat)	
		Breast	Thigh	Breast	Thigh
Se (mg/kg)	Vitamin E (mg/kg)				
	50	173.3	182.4	8.52	11.0
0.15	100	181.9	204.8	11.3	14.1
	200	195.1	219.6	13.4	17.8
	50	173.3	229.5	8.85	12.4
0.30	100	210.6	243.7	11.6	15.1
	200	229.2	263.4	12.8	18.5
Se (mg/kg)					
0.15		183.4^{b}	202.3^{b}	11.0	14.0^{b}
0.30		204.4^{a}	245.5^{a}	11.1	15.3^{a}
Vitamin E (mg/kg)					
50		173.3^{b}	205.9^{b}	8.69^{b}	11.7^{c}
100		196.2^{ab}	224.2^{ab}	11.51^{a}	14.6^{b}
200		212.2^{a}	241.5^{a}	13.11^{a}	17.7^{a}
Pooled SEM		5.10	4.37	0.32	0.33
P value					
Se		0.04	0.01	0.98	0.02
Vitamin E		0.01	0.01	0.01	0.01
Se × vitamin E		0.35	0.93	0.80	0.83

Supplementation of 0.30 mg/kg Se to the broiler chickens significantly (P<0.05) improved the Se deposition (µg/kg) in breast and thigh meat compared to 0.15 mg/kg Se. Similarly, Khan et al. (2011) stated that, excess supplementation of micro nutrients to broiler chicken could increase their concentration in the meat. In the present study, birds supplemented with higher levels of VE also increased (P<0.01) the Se deposition in breast and thigh meat. Supplementation of VE at 200 mg/kg diet deposited significantly (P<0.01) higher Se in breast and thigh meat compared to 50 mg/kg. Whereas, Se concentration in breast and thigh meat with 100 mg/kg VE supplementation was statically comparable to other VE supplemented groups (VE_{50}d"VE_{100}d"VE_{200}). However, the mechanism of this synergism remained unclear. It can be speculated that, VE acts as first line of defence against peroxidation by being a component in cellular and subcellular membranes, thereby inhibiting the production of hydroperoxides, and might have spared the use of Se for antioxidant purpose. In agreement, Yoon et al. (2007) noticed a linear increase (P<0.05) in Se concentration in blood with increased Se concentration (0.1, 0.2 and 0.3 mg/kg) in broilers diet. The present study results are in consistent with previous findings (Celi et al., 2014, Mihaljev et al., 2007;Oliveira et al., 2014;Halaand Fathy, 2014) where a significant increase in the Se deposition in the meat with increased dietary Se supplementation was observed. We did not observe any interaction effect of Se and VE in the present study.

Vitamin E (mg/kg meat) deposition in the thigh meat was increased (P<0.01) in proportion to the dietary VE concentration and highest (P<0.01) VE

deposition was observed with 200 mg/kg VE supplementation (VE_{50}<VE_{100}<VE_{200}). In breast meat, the VE deposition was significantly (P<0.01) increased, as dietary VE supplementation was increased from 50 to 100 mg/kg diet, but further increase (200 mg/kg) in VE concentration had no significant influence on VE deposition in the meat (VE_{50}<VE_{100}=VE_{200}) and it was statistically comparable to 100 mg/kg VE supplemented group. Increased VE concentration in the diet might be the reason for increased VE deposition in the meat(Khan et al., 2011). Similarly, Cortinas et al. (2006) stated that VE deposition in the chicken meat increases as the VE concentration increases in diets. In current investigation, no effect of Se and VE interaction was observed but increased Se concentration (from 0.15 to 0.30 mg/kg) in the diet significantly (P<0.05) increased the VE deposition in the thigh meat but this Se influence was not observed in the breast meat. Exact mechanism for trend in current results is unclear, but this might be due to higher (0.30 mg/kg) levels of Se supplementation which might have actively removed the lipid peroxides from the cells by being a component of GPx, thereby might have spared the VE for this purpose. Furthermore, Se has a positive influence on VE absorption, metabolism and transport to target tissue (McDowell, 2003). This might be another reason for increased VE deposition in the thigh meat with increased Se supplementation. Present results are in agreement with the Skøivan et al. (2008) findings that, increased dietary Se supplementation had significantly increased the VE deposition in the meat. From these findings, it can be inferred that, dietary addition of 0.3 mg/kg Se and 200 mg/kg VE to broiler chicken diet, could effectively increase Se and VE deposition in breast and thigh meat.

Overall conclusion is that, broiler chicken meat can be enriched with Se and VE without affecting birds' performance and carcass trait, with inclusion of 0.30 mg/kg Se and 200 mg/kg VE to broilers diet. In addition, increased Se and VE supplementation improved the immunity response of birds.

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