Poultry Science Journal
ISSN: 2345-6604 (Print), 2345-6566 (Online) http://psj.gau.ac.ir
DOI: 10.22069/psj.2018.13815.1276

Effect of Different Levels of Nano-selenium on Performance, Blood Parameters, Immunity and Carcass Characteristics of Broiler Chickens

Ahmadi M[1], Ahmadian A[2] & Seidavi AR[2]

[1]Department of Animal Science, Ilam Branch, Islamic Azad University, Ilam, Iran
[2]Department of Animal Science, Rasht Branch, Islamic Azad University, Rasht, Iran

Poultry Science Journal 2018, 6(1): 99-108

Keywords
Immunity
Hematology
Broiler chicken
Nano-selenium

Corresponding author
Mansour Ahmadi
m_ahmadi@ilam-iau.ac.ir

Article history
Received: August 11, 2017
Revised: January 28, 2018
Accepted: February 2, 2018

Abstract

The aim of the present study was to test the hypothesis that nano-seleniuminclusion in broilers' diets can improve productivity and metabolic functions of broilers.Feed and water were provided *ad libitum*. A total of 180 one-day old male Ross 308 chicks were randomly assigned to six groups based on a completely randomized design, each with three replicates of 10 birds. One of the groups served as the control (CON) and was given a basal diet without further dietary supplementation, whereas the other five groups were offered the same starterandgrower diets further supplemented with dietary nano-selenium (NS) at 0.1 mg/kg of feed (NS1), 0.2 mg/kg of feed (NS2), 0.3 mg/kg of feed (NS3), 0.4 mg/kg of feed (NS4), and 0.5 mg/kg of feed (NS5). Nano-selenium dietary supplementation significantly improved weight gain and feed conversion ratio in starter (1^{st}-21^{st} day), grower (22^{nd}-42^{nd} day) and whole (1^{st}-42^{nd}) periods of experiment ($P < 0.05$). At the same time, energy and protein utilization was more efficient in NS supplemented groups than the control ($P < 0.05$). Breast and drumsticks percentages had higher values in the NS supplemented birds than the control ($P < 0.05$), while abdominal fat percentage had lower values in the NS supplemented birds than the control ($P < 0.05$).Significant differences in relative weight of testes were observed between treatments ($P < 0.05$). Glucose and total protein concentrations in blood plasma were not significantly different among the experimental groups ($P > 0.05$). While, albumin levels in blood were decreased and anti-Newcastle disease hemagglutination-inhibition titer was increased after the dietary supplementation with the nano-selenium ($P < 0.05$). As conclusion, the current study demonstrated that the supplementation of nano-selenium in broiler diets could improve growth performance, carcass components and immune function, without negative effects on internal organs, and other carcass parameters and gastrointestinal parts.

Introduction

Selenium is one of essential minerals required for optimal growth and productivity in birds. It supports multiple functions related to poultry production, fertility, and disease prevention. Selenium - as an integral part of the enzyme glutathione peroxidase- serves as an antioxidant enzyme and helps to control levels of hydrogen peroxide and lipid peroxides. These matobilites are produced during normal metabolic activity (Rotruck *et al*., 1973; Canoğullari *et al*., 2010; Baylan *et al*., 2011). Van Beirendonck *et al*. (2016) found there is a relation between selenomethionine content in dietary

Please cite this article as: Ahmadi M, Ahmadian A & Seidavi AR. 2018. Effect of Different Levels of Nano-selenium on Performance, Blood Parameters, Immunity and Carcass Characteristics of Broiler Chickens. Poult. Sci. J. 6(1): 99-108.

selenium sources and selenium deposition in broiler muscle tissue. Rao *et al*. (2016) stated supplementing organic forms of selenium had positive effect on performance, anti-oxidant and immune responses in broiler chicken reared in tropical summer.There are some evidences on positive effects of organic selenium on hen performance and productivity of broiler breeders (Rajashree *et al*., 2014). Meanwhile there is a relationship between fatty acids profile of meat from broiler chickens supplemented with inorganic or organic selenium (del Puerto *et al*., 2017).

The maximum amount for selenium in diets has been set at 0.5 mg/kg based on the European Union (2004) recommendation to ensure feed safety. The bioavailability of selenium is lareglycorrelated with its physical form. Nano-selenium (NS) has attracted widespread attention nowadays, since nanometer particulates exhibit novel characteristics such as large surface, excellent surface activity, good catalytic efficiency, high absorbing ability, and low toxicity (Wang *et al*., 2007; Zhang *et al*., 2008). Some data exist that evaluategrowthperformance parameters of commercial broilers fed with NS supplemented diets (Wang *et al*., 2007; Wang, 2009; Cai *et al*., 2012; Hu *et al*., 2012; Mahmoud *et al*., 2016; Moghaddam *et al*., 2017). However more researches are necesssary for determination of its optimal doses in different fields. The aim of the present study was therefore to test the hypothesis that NS inclusion in broilers' diets can improve productivity and metabolic functions of broilers.

Materials and Methods

Animals and treatments

This study was conducted at a commercial poultry farm at Rasht, Iran equipped to neccessory facilities and conditions for research. A total of 180 one-day old male (Ross 308) chicks were individually randomly assigned to six groups, each with three replicates of 10 birds based on a completely randomized design. Each replicate was housed in a floor pen (1 m × 1 m). Thermo-neutral ambient temperature was maintained in accordance to standard brooding practices and adapted to the birds rearing stages (Aviagen, 2014). Light regime was regulated as follows: 23 h light and 1 h dark (1st-7th day), 20 h light and 4 h dark (8th-39th day), and 22 h light and 2 h dark (40th-42nd day). The birds were vaccinated as water drinking against infectious Bronchitis virus (IBV) (H120; 1st day of age), Newcastle disease (8th and 21st day of age), influenza (1st day of age) and Gumboro disease (IBD071IR; 14th and 23rd day of age).

Feed and water were provided *ad libitum* in chute feeders and conical drinkers, apart from the 1st week when feeder trays were used. One of the groups served as the control (CON) and was given a basal diet without further dietary supplementation, whereas the other five groups were offered the same starter and grower diets further supplemented either with dietary NS (Farzanegan Co, Iran) at 0.1 mg/kg of feed (NS1), or 0.2 mg/kg of feed (NS2), 0.3 mg/kg of feed (NS3), 0.4 mg/kg of feed (NS4), 0.5 mg/kg of feed (NS5). Diets were formulated according to Ross manual recommendations and offered as mash form. Table 1 shows the ingredients and the composition of the basal (control) starter and grower diets used in the present experiment.

Performance and carcass characteristics

Body weight and feed intake were weekly recordedgrouply for each pen. Feed conversion ratio, energy intake, energy efficiency ratio, protein intake, and protein efficiency ratio were further calculated based on conventional protocols (Aziz-Mousavi *et al*., 2015). Carcass characteristics measured based on Poorghasemi *et al*. (2013). Briefly, at the age of 42nd day, one chick per replicate (three chicks per treatment) was selectedclose to mean body weight of replicate, fasted for 4h. Feet were separated from the carcass in the tibio-tarsal joint. Weights of carcass parts, abdominal fat, internal organs (liver, thymus, heart, lungs, kidneys, pancreas, testes), and gastrointestinal tract characteristics (crop, proventriculus, gizzard, right and left cecum) were measured. The length, width and wall thickness of left and right cecum were also recorded. Total weight of all dissected parts and the weights of various segments of the digestive tract were expressed as a percentageof carcass, according to the following formula: [(weight of component(s)/carcass weight) × 100].

The procedures used in the present study were approvedby the Ethic Committee of the Islamic Azad University, and was conducted in respect to the International Guidelines for research involving animals.

Table 1. Feed ingredients and nutrient analysis of the basal diet (%, unless mentioned)

Ingredients	Starter (1st -21st day of age)	Grower (22nd-42nd day of age)
Corn	58.6	61.6
Soybean meal (44% CP)	36.2	33.5
Soybean oil	1.40	1.50
Calcium Carbonate	0.80	0.90
Gluten meal	0.65	0.16
Dicalcium Phosphate	1.30	1.15
NaCl	0.25	0.32
Mineral premix*	0.25	0.25
Vitamin premix**	0.25	0.25
DL-Methionine	0.25	0.30
L-Lysine hydrochloride	0.05	0.07
Nutrient analysis		
ME (Kcal/kg)	2950	3000
Crude Protein	21.0	20.0
Calcium	0.95	0.90
Available Phosphorus	0.47	0.45
Sodium	0.17	0.15
Chloride	0.18	0.17
Lysine	1.12	1.05
Methionine	0.48	0.45
Methionine + Cystine	0.80	0.75
Threonine	0.74	0.70

*Supplied per Kg of mixture: 1,081 mg *trans*-retinol; 20 mg cholecalciferol; 4 mg α-tocopherol acetate; 800 mg menadione; 720 mg thiamine; 2,640 mg riboflavin; 4,000 mg niacin; 12,000 mg calcium pantothenate acid; 1,200 mg pyridoxine; 400 mg folic acid; 6 mg cyanocobalamin; 40 mg biotin; 100,000 mg choline; 40,000 mg antioxidant.

** Supplied per Kg of mixture: 39,680 mg manganese; 20,000 mg iron; 33,880 mg zinc; 4,000 mg copper; 400 mg iodine; 80 mg selenium; 1 mg excipient.

Plasma metabolites and hepatic enzymes

Blood constitutes measured based on Jahanpour *et al*. (2013). Briefly, at the end of the experiment (42nd day) one bird from each replicate (three chicks per treatment) was randomly selected for blood sampling. Collection of blood was performed early in the morning to minimize the circadian variations in the examined plasma parameters. Feed was also removed for a period of 4 h before sampling for the same reason. Blood samples (5 mL/bird) were collected from the wing vein (*Vena cutaneaulnaris*) into tubes coated with 10 mg of the anticoagulant ethylenediaminetetraacetic acid (EDTA). Samples were rapidly transferred to the laboratory (within 2 h of collection), centrifuged at 3000 × g for 10 min at room temperature and blood plasma was stored at -20°C for further analyses. Blood parameters determined in the present study wereglucose (Glu), albumin (Al), and total protein (TP) by using a Roche Cobas Integra autoanalyzer (Roche Diagnostics, GmbH, Mannheim, Germany). Their analysiswas performed using commercial kits (Pars Azmoon Co., Tehran, Iran), according to the manufacturer's instructions, as described in previous studies (Nahavandinejad *et al*., 2014; Shabani *et al*., 2015).

Immune competency

One bird perreplicate (three birds per treatment) was randomly selected and blood samples were collected from the brachial veinat the 26th day of age. Serum was separated by centrifugation (3000 × *g* for 15 min) and was stored at -20°C until further analyses. Response to the Newcastle lentogenic vaccine (vaccine titres) was assessed based on the haemagglutination inhibition (HI) assays following the procedure described in previous works (Seidavi *et al*., 2014; Ebrahimi *et al*., 2015).

Statistical analysis

Shapiro-Wilks test confirmed the normal distribution of data and were therefore analyzed according to a completely randomized experimental design involving six treatments by using the General Linear Model procedures of the IBM SPSS Statistics 21 software for Windows® (SPSS, 1997). Significant differences were assessed via Tukey's post hoc test at 0.05 significance level and the results are presented as means ± standard error of means (*SEM*).

Results and Discussion

As shown in Table 2, nano-selenium dietary supplementation significantly improved weight gain and feed conversion ratio in starter, grower, and whole periods of experiment. These findings can be due to higher requirment of broilers to selenium. At the same time, energy and protein utilization was more efficient in NS supplemented groups than the control. In fact, selenium have some roles in energy metabolism (Hawkes and Keim, 2003), and these findings are predictable. Improved daily weight gain and feed conversion ratiowere also observed in avian broilers (Wang and Xu, 2008), or Guangxi Yellow chickens (Zhou and Wang, 2011) fed a diet supplemented with nano-selinium at the doses of 0.2-0.5 mg/kg. It could be due higher absorption/utilization of selenium compared to CON group.

Table 2. Growth performance parameters as affected by the different levels of dietary nano-selenium supplementation

Groups*	Feed intake (g/day)	Weight gain (g/day)	Feed Conversion Ratio	Energy Intake (kcal/day)**	Energy Efficiency Ratio (kcal/g)**	Protein Intake (g/day)**	Protein Efficiency Ratio**
Starter period (1st-21st days of age)							
CON	47.667	31.841^{c}	1.497^{a}	144.192	4.528^{a}	10.963	0.344^{a}
NS1	47.302	32.381^{bc}	1.461^{b}	143.087	4.420^{b}	10.879	0.336^{b}
NS2	46.063	33.063^{abc}	1.393^{d}	139.342	4.215^{d}	10.595	0.320^{d}
NS3	47.683	34.317^{bc}	1.390^{d}	144.240	4.204^{d}	10.967	0.320^{d}
NS4	48.444	34.698^{a}	1.396^{d}	146.544	4.223^{d}	11.142	0.321^{d}
NS5	47.556	33.476^{abc}	1.421^{c}	143.856	4.297^{c}	10.938	0.327^{c}
P-value	0.530	0.058	<0.001	0.530	<0.001	0.530	<0.001
SEM	0.837	0.640	0.004	2.533	0.013	0.193	0.001
Grower period (22nd-42nd days of age)							
CON	159.476	73.317^{d}	2.175^{a}	502.350	6.852^{a}	33.490	0.457^{a}
NS1	160.556	76.254^{c}	2.106^{b}	505.750	6.632^{b}	33.717	0.442^{b}
NS2	163.111	78.968^{abc}	2.065^{cd}	513.800	6.506^{cd}	34.253	0.434^{cd}
NS3	164.889	80.524^{a}	2.047^{d}	519.400	6.449^{d}	34.627	0.430^{d}
NS4	164.016	79.476^{ab}	2.064^{cd}	516.650	6.501^{cd}	34.443	0.433^{cd}
NS5	162.254	77.587^{bc}	2.091^{bc}	511.100	6.587^{bc}	34.073	0.439^{bc}
P-value	0.454	0.001	<0.001	0.454	<0.001	0.454	<0.001
SEM	2.054	0.859	0.011	6.470	0.034	0.431	0.002
Whole period (1st-42nd days of age)							
CON	103.571	52.579^{d}	1.970^{a}	326.250	6.205^{a}	21.750	0.414^{d}
NS1	103.929	54.317^{c}	1.913^{b}	327.375	6.027^{b}	21.825	0.402^{c}
NS2	104.587	56.016^{ab}	1.867^{cd}	329.450	5.881^{cd}	21.963	0.392^{cd}
NS3	106.286	57.421^{a}	1.851^{d}	334.800	5.830^{d}	22.320	0.389^{d}
NS4	106.230	57.087^{a}	1.861^{d}	334.625	5.862^{d}	22.308	0.391^{d}
NS5	104.905	55.532^{bc}	1.889^{bc}	330.450	5.951^{bc}	22.030	0.397^{bc}
P-value	0.373	0.000	0.000	0.373	0.000	0.373	0.000
SEM	1.048	0.455	0.009	3.301	0.027	0.220	0.002

Means within each column with no common superscript differ significantly at $P < 0.05$.

* CON: control, without supplementation, NS1: supplemented with nano-selenium at 0.1 mg/kg DM of feed, 0.2 mg/kg of feed (NS2), 0.3 mg/kg of feed (NS3), 0.4 mg/kg of feed (NS4), 0.5 mg/kg of feed (NS5).

**Calculated based on Aziz-Mousavi *et al.*, (2015).

The results of the present study are also in accordance with that of Sevcikova *et al*. (2006) and Dlouha *et al*. (2008), since they declared an improvement in body weight due to the selenium dietary supplementation at the level of 0.3 mg/kg. Wang and Xu (2008) also observed an improvement of feed conversion ratio after the dietary supplementation with Se at the level of 0.2 mg/kg both in the form of sodium selenite and selenium yeast. At the same time, Hu *et al*. (2012) found that average daily gain and gain/feed intake ratio increased linearly and quadratically as the level of nano-selinium increased in the diet from 0.15 to 1.20 mg/kg. On the other hand, Cai *et al*. (2012) indicated no significant differences in weight gain, feed

intake, and feed conversion ratio in broilers fed diets supplemented with 0.3 to 2.0 mg nano-selinium per kg of diet. Similar results have also been shown by Ryu *et al*. (2005) even when the supplemental level was 8 mg/kg.

Breast and drumsticks percentages had higher values in the NS supplemented birds than the control, while adominal fat percentage had lower values in the NS supplemented birds than the control (Table 3). No differences among the experimental groups were found in the weights of edible organs (liver, heart and gizzard) (Table 3), non edible organs (lungs, kidneys, pancreas, testes, crop, proventriculus, right and left cecum) (Table 4), length, width and diameter of the right and left cecum) (Table 5), and thymus (Table 6). However, significant differences in relative weight of testes were observed between treatments (Table 4).

Table 3. Relative weight of carcass components as affected by the different levels of dietary nano-selenium supplementation (% of live body weight)

Groups*	Breast	Drumsticks (thighs)	Wings	Abdominal fat	Liver	Heart	Gizzard
CON	20.904^{b}	11.907^{b}	6.006	1.912^{a}	2.615	0.510	1.743
NS1	22.319^{a}	12.919^{a}	6.316	1.075^{bc}	2.596	0.623	1.858
NS2	22.369^{a}	12.940^{a}	5.722	1.662^{ab}	2.654	0.696	1.946
NS3	22.422^{a}	12.923^{a}	3.254	0.991^{c}	2.324	0.489	1.882
NS4	22.406^{a}	12.911^{a}	5.279	1.182^{bc}	2.788	0.607	1.586
NS5	22.414^{a}	12.935^{a}	5.877	0.968^{c}	2.341	0.606	1.951
P-value	< 0.0001	< 0.0001	0.181	0.015	0.392	0.601	0.956
SEM	0.167	0.036	0.819	0.185	0.172	0.088	0.314

Means within each column with no common superscript differ significantly at $P< 0.05$.
* CON: control, without supplementation, NS1: supplemented with nano-selenium at 0.1 mg/kg DM of feed, 0.2 mg/kg of feed (NS2), 0.3 mg/kg of feed (NS3), 0.4 mg/kg of feed (NS4), 0.5 mg/kg of feed (NS5).

Table 4. Relative weight of non edible organs as affected by the different levels of dietary nano-selenium supplementation (% of live body weight)

Groups*	Lungs	Kidneys	Pancreas	Testes	Crop	Proventriculus	Right cecum	Left cecum
CON	0.299	0.516	0.211	0.072^{a}	0.715	0.381	0.296	0.596
NS1	0.261	0.506	0.247	0.054^{b}	0.701	0.412	0.253	0.303
NS2	0.295	0.520	0.238	0.076^{a}	0.494	0.399	0.256	0.269
NS3	0.259	0.631	0.298	0.067^{ab}	0.989	0.400	0.333	0.370
NS4	0.284	0.549	0.201	0.067^{ab}	0.791	0.505	0.275	0.368
NS5	0.259	0.624	0.268	0.060^{ab}	0.462	0.375	0.255	0.437
P-value	0.687	0.726	0.114	0.011	0.749	0.787	0.262	0.282
SEM	0.024	0.075	0.024	0.774	0.268	0.069	0.026	0.097

Means within each column with no common superscript differ significantly at $P< 0.05$.
* CON: control, without supplementation, NS1: supplemented with nano-selenium at 0.1 mg/kg DM of feed, 0.2 mg/kg of feed (NS2), 0.3 mg/kg of feed (NS3), 0.4 mg/kg of feed (NS4), 0.5 mg/kg of feed (NS5).

Table 5. Length, width and diameter of right and left cecum as affected by the different levels of dietary nano-selenium supplementation (mm)

Groups*	Right cecum			Left cecum		
	length	width	diameter	length	width	diameter
CON	15.333	7.983	0.193	15.370	3.603	0.217
NS1	17.667	8.527	0.280	16.600	4.027	0.360
NS2	16.333	12.040	0.290	15.837	2.877	0.353
NS3	16.333	9.720	0.420	16.717	6.213	0.283
NS4	17.000	10.810	0.260	16.420	4.587	0.283
NS5	16.333	7.900	0.257	16.277	5.003	0.290
P-value	0.729	0.197	0.155	0.791	0.433	0.593
SEM	1.045	1.265	0.053	0.743	1.136	0.061

Means within each column with no common superscript differ significantly at $P< 0.05$.
* CON: control, without supplementation, NS1: supplemented with nano-selenium at 0.1 mg/kg DM of feed, 0.2 mg/kg of feed (NS2), 0.3 mg/kg of feed (NS3), 0.4 mg/kg of feed (NS4), 0.5 mg/kg of feed (NS5).

Although there is some report about relationship between selenium and gastrointestinal characteristics (Wang *et al*., 2013) and carcass components (Naik *et al*., 2015; Konieczka *et al*., 2015), however scarce literature exists regarding the effect of nano-selenium dietary supplementation on the above parameters in broilers. However, these findings can clarify the effects of nano-selenium on gastrointestinal segment's function and output. Zhang *et al*., (2016) demonstrated selenium deficiency affects the mRNA expression of inflammatory factors and selenoprotein genes in the kidneys of broiler chicks. Zhang *et al* (2017) revealed a disbalance of calcium regulation-related genes in broiler hearts induced by selenium deficiency. Cao *et al*. (2017) found an inflammatory response occurs in veins of broiler chickens treated with a selenium deficiency diet. Sevcikova *et al*. (2006) demonstrated no effect of Se dietary supplementation in form of Se-yeast or Se-Chlorella (0.3 mg/kg) on the weights of breast, thigh, liver, giblets and abdominal fat. The results of the present study are in agreement with that of Downs *et al*., (2000) and Payne and Southern (2005), who showed that carcass traits were not affected by selenium addition (sodium selenite or selenium-enriched yeast) in the diets of broilers. Cai *et al*., (2012) and Chen *et al*., (2014) found no effect of selenium addition (nano-selenium or sodium selenite/selenium-enriched yeast, respectively) on the weights of bursa of Fabricius, thymus and spleen. Shirsat *et al*., (2016) found protective role of biogenic selenium nanoparticles in immunological and oxidative stress generated by enrofloxacin in broiler chicken. Overally, there is not enough evidence for positive efects of supra concentrations of selenium on broiler immunity (Swain *et al*., 2000). Dalia *et al.* (2017) found an effect of dietary bacterial organic selenium on growth performance, antioxidant capacity, and selenoproteins gene expression in broiler chickens. Colnago *et al*. (1994) deminstrated high doses of selenium could increase the leukocyte numbers and improve immunity to coccidiosis in chickens. Immunoglobulins contains selenium at disulfide bonds, hence the optimum levels of selenium can develope the immunity functions (Burton *et al*., 1977).

Glucose and total protein concentrations in blood plasma were not significantly different among the experimental groups (Table 6). Glucose is affected by vitamin E and selenium somewhat, since vitamin E and selenium decrease the cellular oxidative stress, so it preserve the beta cells of liver as glucose regulator. On the other hand, albumin levels in blood were decreased except for NS5 which is due to dehydratation duing sampling period, and only NS3 and NS5 indicated significant increases compared to the control for anti-Newcastle disease hemagglutination-inhibition titer after the dietary supplementation with the nano-selenium (Table 6). There was no significant difference between other treatments and the control.

Table 6. Plasma constitutes, relative weight of organ related with immune system, and anti-Newcastle disease hemagglutination-inhibition titers as affected by the different levels of dietary nano selenium supplementation

Groups*	Glucose (mg/dL)	Albumin (g/dL)	Total protein (g/dL)	Thymus (% of LBW)**	ND titer (log 10)***
CON	81.843	1.281^{a}	3.697	0.189	3.333^{b}
NS1	95.490	0.069^{b}	3.503	0.593	3.667^{b}
NS2	52.933	0.102^{b}	4.093	0.633	5.333^{ab}
NS3	125.947	0.090^{b}	3.500	0.170	6.333^{a}
NS4	65.980	0.154^{b}	3.397	1.083	5.333^{ab}
NS5	169.507	1.172^{ab}	2.610	0.169	6.333^{a}
P-value	0.123	0.057	0.414	0.312	0.018
SEM	29.011	0.338	0.467	0.318	0.624

Means within each column with no common superscript differ significantly at $P< 0.05$.

* CON: control, without supplementation, NS1: supplemented with nano-selenium at 0.1 mg/kg DM of feed, 0.2 mg/kg of feed (NS2), 0.3 mg/kg of feed (NS3), 0.4 mg/kg of feed (NS4), 0.5 mg/kg of feed (NS5).

** Relative weight of thymus (% of live body weight; *** Anti-Newcastle disease hemagglutination-inhibition at 26th day of age.

Selenium can improve plasma lipoproteins i.e. decline the LDL-c (low density lipoprotein-cholestrol), cholesterol and plasma trigelycerides, and increase HDL-c (high density lipoprotein-cholesterol) cholesterol (Iizuka *et al*., 2001). Shen and Sevanian (2001) found the selenium defiency led to glutathione destroy under improvement of macrophage activity, and the other hand it increase the gamma glutamyl cysteine synthetase, hence inhibit glutathione synthetase enzyme. So, the oxidized LDL-c will increase hydroperoxide lipids and aldehydes and then destroy the lipids. LDL-c acetate increasesthe gamma glutamyl cysteine synthetase, and hence increases glutathione and glutathione peroxidase (Holovska *et al*., 2003). Meanwhile, selenium deficiency result to free radicals production and there radicals affect on malondialdehyde, and so increase the plasma cholestrol (Kuklinski *et al*., 1991). Similarly, in a previous study, antibody levels of IgM were increased in groups fed using 0.3-1.0 mg/kg of nano-selenium and chicks supplemented 0.30 mg/kg of nano-selenium had the highest IgG and IgM titres (Cai *et al*., 2012). On the other hand, no effect of Se dietary supplementation on the content of blood immunoglobulins was found by Chen *et al*. (2014). These finding can be due higher absorption of nano-particles of selenium against organic/non organic selenium.

Conclusion

The current study demonstrated that the supplementation of nano-selenium in broiler diets could improve growth performance parameters and immune function, without negative effects on internal organs, carcass parameters and gastrointestinal parts. It is recommend to use higher doses until a negative effect is expected in next studies.

Acknowledgments

Financial support by Ilam Branch, Islamic Azad University is gratefully acknowledged.

References

Aviagen, 2014. Ross 308 broiler: Nutrition Specification. Aviagen, Scotland, UK.

Aziz-Mousavi SMA, Seidavi AR, Dadashbeiki M, Kilonzo-Nthenge A, Nahashon SN, Laudadio V & Tufarelli V. 2015. Effect of a synbiotic (Biomin® IMBO) on growth performance traits of broiler chickens. European Poultry Science, 79: 1-15. DOI: 10.1399/eps.2015.78

Baylan M, Canogullari S, Ayasan T, & Copur G. 2011. Effects of dietary selenium source, storage time, and temperature on the quality of quail eggs. Biological Trace Element Research, 143: 957-964. DOI: 10.1007/s12011-010-8912-x

Burton RM, Higgins PJ, & McConnell KP. 1977. Reaction of selenium with immunoglobulin molecules. Biochimistry and Biophysics Acta. 493: 323-331. DOI: 10.1016/0005-2795(77)90188-X

Cai SJ, Wu CX, Gong LM, Song T, Wu H & Zhang LY. 2012. Effects of nano-selenium on performance, meat quality, immune function, oxidation resistance and tissue selenium content in broilers. Poultry Science, 91: 2532-2539. DOI: 10.3382/ps.2012-02160

Canoğullari S, Ayaşan T, Baylan M, & Çopur G. 2010. The effect of organic selenium on performance characteristics, egg production parameters and egg selenium content of laying Japanese quail. Journal of the Faculty of Veterinary Medicine, Kafkas University, 16: 743-749.

Cao C, Fan R, Chen M, Li X, Xing M, Zhu F, Xue H, Wang K & Xu S. 2017. Inflammatory response occurs in veins of broiler chickens treated with a selenium deficiency diet. Biological Trace Element Research, 173: 1-9. DOI: 10.1007/s12011-017-1145-5

Chen G, Wu J & Li C. 2014. Effect of different selenium sources on production performance and biochemical parameters of broilers. Journal of Animal Physiology and Animal Nutrition, 98: 747–754. DOI: 10.1111/jpn.12136

Colnago GL, Jensen LS, & Long PL. 1994. Effect of selenium and vitamin E on the development of immunity to coccidiosis in chickens. Poultry Science, 63: 1136-1143. DOI: 10.3382/ps.0631136

Dalia AM, Loh TC, Sazili AQ, Jahromi MF, & Samsudin AA. 2017. The effect of dietary bacterial organic selenium on growth performance, antioxidant capacity, and Selenoproteins gene expression in broiler chickens. BMC Veterinary Research, 13: 254. DOI: 10.1186/s12917-017-1159-4

del Puerto M, Cabrera MC, & Saadoun A. 2017. A note on fatty acids profile of meat from broiler chickens supplemented with inorganic or organic selenium. International Journal of Food Science, 2017: 1-8. DOI: 10.1155/2017/7613069

Dlouha G, Sevcikova S, Dokoupilova A, Zita L, Heindl J, & Skrivan M. 2008. Effect of dietary selenium sources on growth performance, breast muscle selenium, glutathione peroxidase activity and oxidative stability in broilers. Czech Journal of Animal Science, 53: 265-269.

Downs KM, Hess JB & Bilgili SF. 2000. Selenium source effect on broiler carcass characteristics, meat quality and drip loss. Journal of Applied Animal Research, 18: 61–72. DOI: 10.1080/09712119.2000.9706324

Ebrahimi A, Santini A, Alise M, Pourhossein Z, Miraalami N & Seidavi A. 2015. Effect of dried *citrus sinensis* peel on gastrointestinal microbiota and immune system traits of broiler chickens. Italian Journal of Animal Science, 14: 712-717. DOI: 10.4081/ijas. 2015.4194

European Union. 2004. List of the authorized additives in feeding stuffs published in application of Article 9t (b) of Council Directive 70/524/EEC concerning additives in feeding stuffs. Off. J. Eur. Union. C/50:1–144.

Hawkes WC, & Keim NL. 2003. Dietary selenium intake modulates thyroid hormone and energy metabolism in men. The Journal of nutrition, 133: 3443-3448. DOI: 10.1093/jn/133.11.3443

Holovska K, Boldizarova K, Cekonova S, Lenartova V, Levkut M, Javorsky P, & Leng L. 2003. Antioxidant enzyme activities in liver tissue of chickens fed diets supplemented with various forms and amounts of selenium. Journal of Animal and Feed Science. 12: 143-152. DOI: 10.22358/jafs/67691 /2003

Hu CH, Li YL, Xiong L, Zhang HM, Song J & Xia MS. 2012. Comparative effects of nano elemental selenium and sodium selenite on selenium retention in broiler chickens. Animal Feed Science and Technology, 177: 204-210. DOI: 10.1016/j.anifeedsci.2012.08.010

Jahanpour H, Seidavi AR, Qotbi AAA, & Payan-Carreira R. 2013. Effects of two levels of quantitative feed restriction for a 7- or 14- days period on broilers blood parameters. Acta Scientiae Veterinariae, 41: 1-11.

Konieczka P, Czauderna M, Rozbicka-Wieczorek A, & Smulikowska S. 2015. The effect of dietary fat, vitamin E and selenium concentrations on the fatty acid profile and oxidative stability of frozen stored broiler meat. Journal of Animal and Feed Sciences, 24: 244-251. DOI: 10.22358/jafs/65630/2015

Kuklinski B, Zimmermann R, Ruhlmann C, Nagel R, & Tessmann D. 1991. Tangier disease-a "free radical"- associates disease. Results of HDL and antioxidant therapy with selenium and D-alpha tocopherol. Zeitschrift fur diegesamteinnere Medizin und ihre Grenzgebiete. 46: 505-511.

Mahmoud H, Ijiri D, Ebeid TA & Ohtsuka A. 2016. Effects of dietary nano-selenium supplementation on growth performance, antioxidative status, and immunity in broiler chickens under thermoneutral and high ambient temperature conditions. The Journal of Poultry Science, 53: 274-283. DOI: 10.2141/jpsa.0150133

Moghaddam AZ, Hamzekolaei MM, Khajali F & Hassanpour H. 2017. Role of selenium from different sources in prevention of pulmonary arterial hypertension syndrome in broiler chickens. Biological Trace Element Research, 136: 1-7. DOI: 10.1007/s12011-017-0993-3

Nahavandinejad M, Seidavi A, Asadpour L & Payan-Carreira R. 2014. Blood biochemical parameters of broilers fed differently thermal processed soybean meal. Revista MVZ Córdoba, 19: 4301-4315.

Naik SK, Tiwari SP, Sahu T, Gendley MK, Dutta GK, & Gilhare VR. 2015. Effect of organic selenium and vitamin E supplementation on physico-chemical characteristics of broiler meat. Journal of Animal Research, 5: 617-621.

Payne RL & Southern LL. 2005. Comparison of inorganic and organic selenium sources for broilers. Poultry Science, 84: 898–902. DOI: 10.1093/ps/84.6.898

Poorghasemi M, Seidavi AR, Qotbi AAA, Laudadio V & Tufarelli V. 2013. Influence of dietary fat source on growth performance responses and carcass traits of broiler chicks. Asian-Australasian Journal of Animal Sciences, 26: 705-710. DOI: 10.5713/ajas. 2012.12633

Rajashree K, Muthukumar T, & Karthikeyan N. 2014. Comparative study of the effects of organic selenium on hen performance and productivity of broiler breeders. British Poultry Science, 55: 367-374. DOI: 10.1080/00071668.2014.921663

Rao SR, Prakash B, Raju MVLN, Panda AK, Kumari RK, & Reddy EPK. 2016. Effect of supplementing organic forms of zinc, selenium and chromium on performance, anti-oxidant and immune responses in broiler

chicken reared in tropical summer. Biological Trace Element Research, 172: 511-520. DOI: 10.1007/s12011-015-0587-x

Rotruck JT, Pope AL, Ganther HE, Swanson AB, Hafeman DG, & Hoekstra WG. 1973. Selenium: Biochemical role as a component of glutathione peroxidase. Science, 179: 588–590. DOI: 10.1126/science.179.4073.588

Ryu YC, Rhee MS, Lee KM & Kim BC. 2005. Effects of different levels of dietary supplemental selenium om performance, lipid oxidation and color stability of broiler chicks. Poultry Science, 84: 809-815. DOI: 10.1093/ps/84.5.809

Seidavi AR, Asadpour L, Dadashbeiki M & Payan-Carreira R. 2014. Effects of dietary fish oil and green tea powder supplementation on broiler chickens immunity. Acta Scientiae Veterinariae, 42: 1-13.

Sevcikova S, Skrivan M, Dlouha G, & Koucky M. 2006. The effect of selenium source on the performance and meat quality of broiler chickens. Czech Journal of Animal Science, 51: 449-457.

Shabani S, Seidavi A, Asadpour L & Corazzin M. 2015. Effects of physical form of diet and intensity and duration of feed restriction on the growth performance, blood variables, microbial flora, immunity, and carcass and organ characteristics of broiler chickens. Livestock Science, 180: 150-157. DOI: 10.1016/j.livsci.2015.07.006

Shen L & Sevanian A. 2001. OxLDL induces macrophage γ-GCS-HS protein expression: a role for oxLDL-associated lipid hydroperoxide in GSH synthesis. Journal of Lipid Research, 42: 813-823.

Shirsat S, Kadam A, Mane RS, Jadhav VV, Zate MK, Naushad M, & Kim KH. 2016. Protective role of biogenic selenium nanoparticles in immunological and oxidative stress generated by enrofloxacin in broiler chicken. Dalton Transactions, 45: 8845-8853. DOI: 10.1039/C6DT00120C

SPSS. 1997. SPSS Base 7.5 for Windows. SPSS, Chicago, IL.

Swain BK, Johri TS & Majumdar S. 2000. Effect of supplementation of vitamin E, selenium and their different combinations on the performance and immune response of broilers. British Poultry Science, 41: 287-292. DOI: 10.1080/713654938

Iizuka Y, Sakurai E & Tanaka Y. 2001. Effect of selenium on serum, hepatic and lipoprotein lipids concentration in rats fed on a high-cholesterol diet. Yakugakuzasshi: Journal of the Pharmaceutical Society of Japan, 121: 93-96. DOI: 10.1248/yakushi.121.93

Van Beirendonck S, Driessen B, Rovers M, Segers L, Ruttens A, & Du Laing G. 2016. Relation between selenomethionine content in dietary selenium sources and selenium deposition in broiler muscle tissue. In The Proceedings of XXV World's Poultry Congress (pp. 63-63).World's Poultry Science Association.

Wang HL, Zhang JS & Yu HQ. 2007. Elemental selenium at nano size possesses lower toxicity without compromising the fundamental effect on selenoenzymes: comparison with selenomethionine in mice. Free Radical Biology and Medicine, 42: 1524-1533. DOI: 10.1016/j.freeradbiomed.2007.02.013

Wang Y, Yan X, & Fu L. 2013. Effect of selenium nanoparticles with different sizes in primary cultured intestinal epithelial cells of crucian carp, Carassiusauratusgibelio. International Journal of Nanomedicine, 8: 4007-4013. DOI: 10.2147/IJN.S43691

Wang Y. 2009. Differential effects of sodium selenite and nano-Se on growth performance, tissue Se distribution, and glutathione peroxidase activity of avian broiler. Biological Trace Element Research, 128: 184-190. DOI: 10.1007/s12011-008-8264-y

Wang YB & Xu BH. 2008. Effect of different selenium source (sodium selenite and selenium yeast) on broiler chickens. Animal Feed Scienceand Technology, 144: 306-314. DOI: 10.1016/j.anifeedsci.2007.10.012

Zhang JL, Xu B, Huang X D, Gao YH, Chen Y & Shan AS. 2016. Selenium deficiency affects the mRNA expression of inflammatory factors and selenoprotein genes in the kidneys of broiler chicks. Biological Trace Element Research, 171: 201-207. DOI: 10.1007/s12011-015-0512-3

Zhang JS, Wang XF, & Xu TW. 2008. Elemental selenium at nano size (nano-Se) as a potential chemopreventive agent with reduced risk of selenium toxicity: Comparison with Se-methylselenocysteinein mice. Toxicological Science, 101: 22–31. DOI: 10.1093/toxsci/kfm221

Zhang Z, Liu M, Guan Z, Yang J, Liu Z, & Xu S. 2017. Disbalance of calcium regulation-related genes in broiler hearts induced by selenium deficiency. Avian Pathology, 46: 265-271. DOI: 10.1080/03079457.2016.1259528

Zhou X & Wang Y. 2011. Influence of dietary nano elemental selenium on growth performance, tissue selenium distribution, meat quality, and glutathione peroxidase activity in Guangxi Yellow chicken. Poultry Science, 90: 680-686. DOI: 10.3382/ps.2010-00977