The Influence Of Selenium Source On Growth Performance, Carcass Traits And Immune Response In Broiler Chickens

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ABSTRACT

An experiment was conducted to investigate the effect of dietary supplemental selenium source on growth performance, carcass traits and immune response (against infectious bursal disease) and concentration of selenium in breast muscle, thigh muscle and liver in broiler chickens.

A total of 120 one day old broiler chicks were used with an average initial weight of 44 gm. Birds were divided into 3 experimental groups each group divided into equal 2 subgroup (20 chicks / each subgroup). Broiler chickens received a basal corn soybean diet (group 1) supplemented with 0.2 mg Se/kg either in the organic form as selenium enriched yeast (group III) or inorganic form as sodium selenite (NaSe) (group II). B.W and FI were determined weelky and BWG and FCR were calculated. Blood samples were collected from each group at one day of age to determine maternal immunity, then at 15,29 and 42 DOA. The sera were collected and used for determination of IHA titres against IBR. Body weight was significantly increased at 21 and 42 DOA while this improvement was highly significant for group III supplemented with organic selenium at the end of the exp. Also feed conversion ratio was improved in both Se supplemented groups while, Se enriched yeast had the best FCR. There were significant differences between groups in carcass traits and dressing percentage. The content of selenium in breast and thigh muscle increased ($P<0.05$) in both experimental groups supplemented with Se source compared to control. But there were no differences in the concentration of basic nutrients between groups in breast, while thigh muscle was significantly differ between groups.

The selenium concentration in liver was higher ($P<0.05$) in both experimental groups compared to the control. Also the supplement of selenium enriched yeast or sodium selenite increased the microelement concentration in muscle. The effect of Se on humoral immune response was evaluated by serum antibody titre against IBD through indirect haemogglutination (IHA) test.

The results indicated that organic selenium supplement improve growth performanc parameters and may help to increase post vaccination humoral immune response against IBD in broiler chickens.

INTRODUCTION

Today's poultry production practices bring with them intense metabolism and other stress factors on birds, often leading to an increase in free radicals production.

Selenium an essential trace element is of fundamental importance to health. Selenium is known to have important roles in reproductive functions and development, immunocompetence and ageing. As a constituent of selenoproteins, selenium has structural and enzymic roles, which is known as antioxidant and catalyst for the production of an active thyroid hormone. Also, selenium is a component of the cell enzyme glutathione peroxidase which has antioxidant protection role *(1)*. The amount of selenium available for assimilation by the tissue is dependent on the form and concentration of the element, while , organic selenium is deposited in the breast muscle more efficiently than inorganic selenium *(2)*. For poultry, there are two sources of selenium organic selenium, mainly

in the form of selenomethionine and inorganic selenium mainly selenate or selenite which are used for dietary supplementation *(3)*. Selenate is the major inorganic selenocompound found is both animal and plant tissues, while organic form predominantly found in grains, fish, meat, poultry and dairy products *(4)*. In June, 2000, the United Stated FAD approved selenium yeast as an organic Se source for the use in broiler chickens. The primary form in the yeast cellular protein component is selenomethionine which is readily available and actively absorbed from the intestine via the Na^+ dependent neutral amino acid pathway, while selenite is passively absorbed *(5)*. Se-yeast is capable of increasing the activity of the selenoenzymes and its bioavailability was found to be higher than that of inorganic Se sources. Furthermore, it has been reported that Se – yeast is superior to NaSe in conditions of induction of feathering *(6)*.

Infectious viral disease of young chicken is of great economic importance because of the resulting morbidity and mortality as well as the immune suppression, So, restoration of normal immune function may increase resistance to infectious diseases and reduce the severity of disease, it can mainly be possible by immunostimulation, which is the enhancement of immune response. Substances capable of these actions may be specific or non – specific immunopotentiators *(7)*.

Many immunostimulating substances have been used in poultry with success, vitamin E and selenium are considered from these agents *(8,9)*. Selenium supplementation enhances the immune status and the ability of the immune system to respond to disease challenges. The parental administration of selenium has been reported to enhance humoral immune response *(10)* in another study *(11)* broiler breeders were supplemented with either inorganic or organic selenium yeast between 20-35 weeks. Antibodies against several diseases were measured in broilers, and showed that for the two of the pathogens tested, infectious bursal disease and reovirus, supplementation of organic yeast selenium allowed a better maternal immunity transfer with 25-30% increase in antibody titer, offering a better protection to the chick and increase livability for the first 10 days.

The present study was conducted to determine and compare the effect of various forms of dietary supplemental selenium on growth performance, carcass traits, breast and thigh muscle Se concentration of broiler chickens, also, to know the effect of selenium supplementation on humoral immune response against IBD in broiler chickens.

MATERIALS AND METHODS

In this study, 120 one – day old broiler chicks were used (with an average weight 44g) and obtained from commercial hatchary. The birds were weighed and randomly divided into 3 experimental groups each group divided into equal 2 subgroup (20 chicks were allocated into each subgroups). All the chicks were vaccinated against Newcastle and Gamboro diseases. The birds were housed in separated clean pens and kept under continuous lighting system with suitable temperature till the end of the experiment.

The basal diet was formulated according to the requirements *(12)* during starter period (0-3 wks) and grower finisher period (3-6 wks). The basal diet was supplemented by different selenium sources as shown in the experimental protocol.

Table 1. Experimental protocol.

Group	Treatment
I	Basal diet (No Se supplement)
II	Basal diet + 0.2 mg/kg inorganic selenium as sodium selenite (Nase)
II	Basal diet +0.2 mg/kg organic selenium, as selenium enriched yeast (selenomethionine)

Chicks were weighed weekly to determine body weight, body weight gain, also amount of feed consumption and feed conversion ratio were calculated. For biochemical studies, blood samples were collected from each group at one day of age to

determine maternal immunity, then at 15, 29 and 42 DOA. The indirect haemagglutination (IHA) antibody titres against IBD was measured in serum samples *(13)* and cumulative mean titre (CMT) of each group were measured for the whole period.

When the experiment terminated at 42 days of age, 10 broiler chickens of average live weight of the group were selected from each group and slaughtered and the carcasses were used to carry out carcass analysis and breast and thigh muscle analysis. Meat samples were finally ground before analysis *(14)* to determine of water content, protein, ash content, and total lipids content of breast and thigh meat. Selenium was determined by atomic absorption spectrophotometer *(15).*

Statistical analysis of data was carried out using linear model of SAS statistical analysis system package *(16)* .

RESULTS AND DISCUSSION

The obtained data in Table 2 showed the effect of dietary selenium source supplementation on growth performance. The data revealed that dietary selenium increases the live weight of chickens significantly at 21 days of age, while at the end of the experiment the live body weight was significantly improved in both experimental groups, while this improvement was highly significant in group III supplemented with organic form of selenium as selenium enriched yeast in comparison to control group I. The Se requirements to support normal broiler chickens is 0.1 ppm *(12)*. The background levels of Se in the basal diets averaged 0.13 ppm during the course of this study.

Although, the background level should have met Se requirements of the broiler chickens involved in our experiment, the data propose that there may be an additional requirement for Se by the faster growing higher yielding broilers that are commonly grown today and that Se supplemented in the organic form may be beneficial than inorganic forms of Se. Our data shows that broilers fed Se enriched yeast were superior to NaSe fed broilers and these results are consistent with other reports *(6,17)* illustrated that NaSe fed broilers lagged behind the Se enriched yeast until 6 weeks of age, because they were slower to feather during the first 5 weeks of age.

Moreover, the performance was in proved in broilers fed Se – enriched yeast when compared to those in the NaSe or Nase treatment groups confirmed by improving body weight and feed conversion ratio *(18)*.

The background levels of Se were sufficient to maintain good performance for broilers but additional Se appeared to be necessary to optimize growth with birds given Se enriched yeast, showing a greater response.

The utilization efficiency of selenium from organic compounds is likely to be influenced by the content of selenomethionine. Selenomethionine (Se–Met) can be the major selenocompound in selenium –enriched yeast *(19).* According to literature data selenium yeast contains 54-74% selenomethionine and other study reported 60-84% of Se- Met and 0.1-15% selenite *(20)*. The Se-Met posses the brush border membrane via the same amino acid route as its sulphur analogue, methionine. Amino acids and small peptides are absorbed very efficiently by the small intestine, thus the organic mineral is effectively smuggled across the intestinal Lumen *(21).*

On the other hand higher live weight and increased feed intake after dietary Se supplementation in the form of sodium selenite or seleno methionine (0.04 to 0.12ppm Se) *(11).* Also it has been reported higher performance and dressing percentage after the application of a dietary supplement of 250 mg vitamin E and 0.2 mg Se in the form of Na_2 SeO_3 *(2)*. While, a significant effect of the addition of 0.3 mg/kg NaSe in the form of selenite and Se enriched yeast on performance traits of broiler chickens was observed *(22)*.

Table 2. Composition of the diets.

Ingredients	Starter (0-3 wk)	Grower finisher (3-6 wk)
Ground yellow corn	55.5	62
Soybean meal 44%	31.7	28.9
Fish meal	6	2
Veg. oil	3	4
Calcium carbonate	1.5	1
Dicalcium phosphate	1	1
L. lysine	0.25	0.1
Vitamin–mineral premix*	0.5	0.5
DL- methionine	0.3	0.2
Sod. Chloride	0.25	0.25
Calculated nutrient content		
ME kcal /kg diet	3007.26	3136.87
CP%	22.75	19.21
Selenium (ppm)	0.129	0.07
Ca %	1.11	0.76
Available (P)	0.46	0.36

***premix**: Each 2.5 Kg contain Vit. A (1000000 IU), Vit. D3 (2000000 IU), Vit .E (10000mg), Vit. K3 (1000 mg), Vit .B1 (1000mg), Vit. B2 (5000mg), Vit. B6 (1500mg), pantothenic acid (10000mg), Vit. B12 (10mg), Niacin (30000mg) , Folic acid (1000mg), Biotin(50mg), Fe (30000mg), Mn (60000mg), Cu (4000 mg) , I (300mg), Co (100mg), Se (100mg) and Zn (50000mg).

Table 3. Influence of selenium source (inorganic Vs. organic selenium) on body weight of broilers (0-6 weeks of age).

Groups / Age/ w	Control (I)	Inorganic Se (II)	Organic Se (III)
Initial1	44.00±0.45[a]	44.13±0.42[a]	44.75±0.32[a]
(1)	182.50±3.22[a]	187.00±2.85[a]	188.50±1.55[a]
(2)	396.50±12.86[a]	416.25±13.44[a]	421.25±7.18[a]
(3)	717.2±4.88[b]	766.66±9.88[a]	779.16±5.83[a]
(4)	1032.28±33.9[b]	1175±31.49[a]	1200.0±11.54[a]
(5)	1453.57±19.41[b]	1592.5±53.07[a]	1646.25±119.90[a]
(6)	1972.86±39.74c	2135.71±37.34[b]	2257.14±35.23[a]

Regarding feed conversion ratio (Table 4) during the experimental period. There is improvement in both Se supplemented groups compared to FCR for broilers in the non- Se supplemented group. The use of NaSe in ross broilers resulted in increased FCR, but replacement of NaSe by organic Se as SP resulted in a 27 point improvement in FCR (2.29 in selenite fed VS 2.02 in Selplex-fed) broiler *(23)*. The FCR data indicated that an additional requirement for Se was necessary for modern broiler chickens. Part of that improved overall FCR can be attributed to improve rates of feathering on Se yeast fed birds *(24)*, which meant that metabolic energy, which could be lost in Nase- fed broilers, was actually retained and stored in the Se yeast fed broilers. Similar improvement in CFR of broilers fed organic selenium, was recorded *(2)*.

Overall feed conversion rate and slaughter weight were significantly improved with organic Se yeast when compared to inorganic selenium, offering the opportunity for better returns on producer investment.

Table 6 showed the effect of selenium source on the content of basic nutrients dry mater, proteins and intra muscular fat in breast and thigh muscle. The result revealed no significant difference in the nutrient in breast muscle while thigh muscle was significantly differ in the concentration of the selected nutrient whereas the intra muscular fat in thigh muscle was found to be 5 times higher than in breast muscle.

Birds that received organic Se in their diets had improved dressing percentage (75.08%) when compared to control birds (74.7%) Table 5. The average dressing percentage of 71% was recorded *(22)* after an addition of 0.3% mg/kg Se in the form of selenite or Se yeast while the carcass and deboned parts yield was not influenced.

Table 5 showed that the carcass analysis prove a significant differences between groups in the weight of breast, thigh muscle, liver and abdominal fat. Birds receiving organic selenium in their diets had improved eviscerated weight, breast yield and reduced drip loss *(2)*. But in other studies *(22,25)* it has been reported that vitamin E and Se source at 0.1ppm did not have a significant influence on evaserated weight, dressing weight and breast filled yield or average Maryland weight at processing. Concerning to the concentration of selenium in breast and thigh muscle and liver was increased in the experimental groups that feed on selenium sources Table 6.

These results are consistent with previous study which *(2)* reported that an increasing supplemented rate from 0.1 to 0.25 mg/kg Se increased breast muscle concentration from 0.232 to 0.278 mg/kg. Both selenium sources and concentration significantly influence the selenium content and improve the Se status of the muscle. Inorganic Se (sodium selenite) was retained at much lower concentration in muscle tissue, and was less efficiently absorbed and was excreted at a higher rate than organic selenium due to their different metabolic pathways *(26)*. This is due to different absorption mechanism for organic and inorganic forms of selenium. The utilization efficiency of Se from organic compounds is likely to be influenced by the content of selenomethionine, which can be the major selenocompund in selenium - enriched yeast *(19)*. Selenium yeast contains 54-74% of selenomethionine according to literature while other study reported 60-84% of Se met and 0.1-15% selenite *(27)*.

Nutrition plays a significant role in the development and function of the immune system *(28)*. The mean titer against IBD measured through IHA revealed that the highest cumulative titre (CMT) were recorded in group III supplemented with organic Se yeast followed by group II supplemented with inorganic NaSe than those of non supplement group I (control). There results indicated that selenium supplementation helps to increase post-vaccination humoral immune response against IBD in broiler chickens. These results are supported by previous observation *(29,30)* which reported that selenium supplementation enhanced the immune system and increases the

natural resistant of animals by increasing response Se of the organism to antigenic stimuli. Moreover, an increase in humoral antibody titres was observed when selenium was used in feed *(5)*.

This higher utilization efficiency of organic selenium and its important role in reproduction functions and development, immunocompetence and ageing as a constituent of selenoproteins and its structural and enzymatic function as antioxidant and catalyze. The production of active thyroid hormone may explain the more significant improvement in poultry production.

From the economic point of view, it was found that feeding broiler chickkens on diet contain 0.2 mg/kg selenium in its organic form increases the economic efficiency and productivity index by 16.4 and 27.5% respectively in comparison to control diet.

Table 4. Influence of selenium source on weekly body weight gain and feed conversion ration in broiler chickens (0-6 weeks).

Group	Treatment (0-3 wks)			
	Body weight (g)	**Body weight gain (g)**	**Feed intake**	**Feed conversion ratio**
I	717.2±4.88[b]	673.6	1057	1.56
II	766.6±9.88[a]	722.52	1085	1.50
III	779.16±5.83[a]	734.71	1121	1.52
	Treatment (3-6 wks)			
I	1973.86±39.74[c]	1283.66	2940	2.3
II	2135.71±37.34[b]	1371.0	3024	2.2
III	2257.14±35.23[a]	1482.14	3080	2.07
	All over treatment (0-6 wks)			
I	1972.86±39.74[c]	1928.86	3997	2.1
II	2135.71±37.34[b]	2091.58	4109	1.96
III	2257.14±35.23[a]	2212.39	4201	1.89
	Economic efficiency			
Parameters		**Group I**	**Group II**	**Group III**
Diet cots (LE/ kg)		1.935	1.935	1.935
Cicken selling (cost (LE/kg BW)		12	12	12
Economic ecciciency %		199.14	215.58	226.59
Perormance index %		93.94	108.96	119.42

Table 5. Influence of selenium source on carcass characteristics of broiler chicken at 6 weeks of age.

Parameter	Group		
	I control (No Se)	II Inorganic Se (NaSe)	III organic Se (Se yeast)
Breast muscle (g)	330±2.04[b]	346.25±1.75[a]	349±1.47[a]
Thigh muscle (g)	327.5±2.62[a]	317.25±1.31[b]	320.25±0.62[b]
Liver (g)	44.9±0.42[b]	46.75±0.21[a]	47.23±0.19[a]
Abdominal fat (g)	13.55±0.18[b]	14.9±0.14[a]	14.87±0.13[a]
Carcass yield %	74.77±0.2[a]	75.03±0.05[a]	75.08±0.08[a]

Table 6. Influence of selenium sources on dry matter, crude protein and intra muscular fat content in breast and thigh muscle.

Parameter	**Groups**		
	I control (No Se)	**II Inorganic Se (Nase)**	**III organic Se (Se yeast)**
Breast muscle			
Dry matter (g/kg)	251.37±0.62[a]	250.07±0.39[a]	249.97±0.91[a]
Crude protein (g/kg)	215.37±0.62[a]	214.47±0.29[a]	214.5±0.19[a]
Intramuscular fat (g/kg)	9.4±0.15[a]	9.26±0.2[a]	9.58±0.15[a]
Thigh muscle			
Dry matter (g/kg)	247.62±0.29[a]	246.26±0.42[b]	246.97±0.33[a]
Crude protein (g/kg)	181.84±0.3[a]	180.89±0.19[b]	182.05±0.32[a]
Intramuscular fat (g/kg)	48.47±0.3[a]	46.4±0.26[b]	47.04±0.21[b]
Concentration of Se in body tissue			
Breast muscle (µg/kg)	51.87±0.13[c]	86.19±0.37[b]	123.38±0.19[a]
Thigh muscle (µg/k)	70.93±0.14[c]	123.27±0.99[b]	246.75±0.68[a]
Liver (µg/kg)	183.78±1.26[c]	270.97±0.94[b]	420.03±0.53[a]

Table 7. IHA titres against IBD as affected by Se supplementation in broiler diets

Groups	Age in days				CMT
	1	15	29	42	
I	40	25	50	65	45
II	41	28	63	78	53
III	40	30	72	85	57

Conclusion

Selenium enriched yeast has beneficial effects on performance and improved physiological responses in broiler chickens support the conclusion that selenomethionine in selenium enriched yeast may be an essential form of Se supplementation for today's poultry and it was the most bioavilable and lower toxic source of selenium to be used in poultry diets. It contribute to improve growth performance in commercial conditions and appears to reduce the impact of stress in commercial farming, lowering mortality rates and improving flock uniformity.

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الملخص العربى

تأثير مصدر السلينيوم على معدلات الاداء ، صفات الذبيحة والاستجابة المناعية فى بدارى التسمين

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لقد تم دراسة تأثير اضافة عنصر السلينيوم على معدلات الاداء – صفات الذبيحة والاستجابة المناعية ضد مرض الجمبورو وتركيز عنصر السلينيوم فى عضلات الصدر والفخذ والكبد فى بدارى التسمين.

وقد تم استخدام عدد ١٢٠ كتكوت عمر يوم وكان متوسط الوزن الحى ٤٤ جرام.

قسمت الطيور الى عدد ثلاث مجاميع تحتوى كل مجموعة على عدد ٤٠ كتكوت. ثم قسمت كل مجموعة الى عدد ٢ من المكررات وتم تغذيتها كتالى :

المجموعة الاولى :- (المجموعة الضابطة) غذيت على عليقة ضابطة دون اى اضافات.

المجموعة الثانية :- غذيت على عليقة ضابطة + ٠,٢ مليجرام سلينيوم غير عضوى (صوديوم سلينيت) لكل كيلوجرام عليقة.

المجموعة الثالثة : غذيت على عليقة ضابطة + ٠,٢ مليجرام سلينيوم عضوى (عنصر السلينيوم + الخميرة) لكل كيلوجرام من العليقة.

ولقد استمرت التجربة لمدة ٦ اسابيع وتم أخذ عينات من الدم للحصول على مصل الدم لقياس مستوى الاجسام المناعية ضد مرض الجمبورو وفى نهاية التجربة تم ذبح عدد ١٠ دجاجات من كل مجموعة لتعين نسبة التصافى ومواصفات الذبيحة كما تم التحليل الكيميائى لعضلات الصدر والفخذ والكبد لتحديد نسبة العناصر الغذائية الاساسية (الرطوبة – البروتين- الدهون- الرماد) وكذلك تم تعين تركيز عنصر السلينيوم فى هذه الانسجة.

ولقد اظهرت النتائج ان تأثير اضافة السلينيوم العضوى والغير عضوى الى العلائق فى خلال فترة التجربة أدى الى :-

- زيادة معنوية فى وزن الجسم خاصة عند سن ٢١، ٤٢ يوم وكانت الزيادة واضحة خاصة فى المجموعة الثالثة التى غذيت على السلينيوم العضوى.
- تحسين فى معامل التحويل الغذئى فى كل من المجموعة الثانية والثالثة وكانت أحسن كفاءة فى المجموعة التى عذيت على سلينيوم عضوى .
- كان هناك اختلاف واضح فى صفات الذبيحة بين المجاميع الثلاثة.
- زيادة كمية السلينيوم فى عضلات الصدر والفخذ فى المجموعة الثانية والثالثة بينما لا يوجد فروق واضحة فى تركيز العناصر الغذائية الاساسية بين المجاميع الثلاثة.
- زيادة كمية السلينيوم فى كبد المجموعة الثانية والثالثة مقارنة بالمجموعة الاولى.
- زيادة المناعة ضد مرض الجمبورو بوضوح فى المجموعة الثانية والثالثة مقارنة بالمجموعة الضابطة (كنترول).

وانتهت النتائج الى :-

ان استخدام السلينيوم كمحفز طبيعى للنمو أدى الى تحسين معامل الاداء فى دجاج التسمين ورفع الحالة المناعية للدجاج دون أى تأثيرات جانبية على الطائر خاصة ضد مرض الجمبورو.