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Influence of Organic Selenium Source on Performance and selenium and vitamin E contents in Male Broilers

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ABSTRACT

An experiment was conducted to assess the effects of replacing sodium selenite (SS) by Se-yeast (SY) in diet on growth performance and selenium and vit E contents in male broilers tissue.One day-old 240 male birds were randomly assigned to 4 treatments with 4 replicates of 15 birds each. The experimental grower diets that were supplemented with SS or SY at 0.3 mg Se/kg of feed, as follows: T1= 0.3 SS, T2= 0.2 SS+0.1 SY, T3= 0.1 SS+0.2 SY, and T4= 0.3 SY were given ad libitum to the birds during a 21 d-old grower period. The basal diet was also, supplemented with 75 mg of vitaminE. SY enrichment of grower diets increased($P \leq 0.05$) both contents of Se and vitamin E in breast and thigh tissues and increased the weight of live chickens significantly ($P < 0.01$). Also, birds fed 3% SY (T4) diet had better ($P \leq 0.05$) feed conversion ratio (FCR) compared to the others treatments. The mortality rate was lowest in T3 and T4.

Keywords: performance, selenium, vitamin E, male broiler

INTRODUCTION

Selenium (Se) has a biological function only when it is incorporated in to different seleno proteins [1]. The Se requirement for broilers throughout the growth period is 0.15 ppm [2]. Selenium is an essential micronutrient required for normal growth and maintenance in poultry. In June, 2000, an organic source of Se such as Se-enriched yeast was approved for use as a feed supplement in poultry diets [3]. Selenium in poultry nutrition was described in reviews by Surai [4,5]. Metabolic paths of organic and inorganic selenium are different. In June, 2000, an organic source of Se such as Se-enriched yeast was approved for use as a feed supplement in poultry diets [3]. The effect of selenium and the comparison of its inorganic and organic sources on performance of broiler chickens were studied by Payne and Southern [6], Ševčíková *et al.* [7], Robert Upton *et al*. [8] and Skřivan *et al*. [9]. They added vitamin E to diets supplemented by inorganic selenium also, observed performance improvement by higher body weight and carcass or portions yields in end of their experiments.

Thus, it is a common practice in the poultry industry to supplement Se in broilers diets. Historically, the Se source that has been used is the inorganic sodium selenite (Na_2SeO_3). Organic Se has a couple of advantages compared to inorganic Se sources. First, the organic Se sources have a greater bio-availability and secondly, organic Se will not under go pro-oxidation because it is already in the organic form [10]. Therefore, in June, 2000, an organic source of Se such as Se-enriched yeast was approved for use as a feed supplement in poultry diets (FDA, 2000). The amount of Se available for assimilation by the tissues is dependent on the form and concentration of the element while organic selenium is deposited in the body tissues more efficiently than inorganic selenium [11]. Increasing dietary selenium improved the Se status or retention of the muscle and oxidative stability of chicken meat during refrigerated storage [11]. Moreover, it is recognized that vitamin E as a strong natural antioxidant help to protect the polyunsaturated fatty acids in cell membranes from peroxidative damage [9,12].

The objective of the present study was to evaluate the effects of Se-enriched yeast (SY, organic source) in diet on performance and selenium and vitamin E content in meat of broiler chicks. The supplementation of selenium, especially organic selenium, might improve meat quality and shelf life of poultry meat [7].

MATERIALS AND METHOD

Diets and husbandry

Six hundred one day-old ROSS-308 unsexed chicks obtained from a commercial hatchery were reared with commercial feed starter from day 1 to 20. On the 21st days, 240 male chickens were sexed, individually weighed and randomly placed in 16 floor pens of 1.5 × 1.5 meters with 15 birds per pen.The chicks were fed by the same starter diet up to 3 weeks of age. The grower (experimental) diets were supplemented with organic Se-yeast (SY or Sel-Plex [SP], Alltech, Inc.) or sodium selenite (SS or Na_2SeO_3) at 0.3 mg Se/kg of feed and were formulated in accordance with the NRC-1994, to contain 200.7 g of CP and 12.91 MJ of ME. The experimental treatments consisted of 3% SS (T1), 2% SS + 1% SY (T2), 1% SS + 2% SY (T3) and 3% SY (T4) and were fed to birds from 21 to 42 days of age. Vitamin E, sodium selenite and Se-yeast supplements were included in the premix. The chicks were maintained on a 24-h constant lighting schedule and both diets and fresh water were offered *ad libitum* until slaughter at 42 d of age. Ingredient composition and nutrient calculation for diets are shown in *Table 1*. The levels of Se were found 0.365 mg/kg, 0.362 mg/kg, 0.371 mg/kg and 0.375 mg/kg for treatments T1, T2, T3 and T4 and there were no major discrepancies between diets with different Se sources.

At five weeks of age, samples of excreta were collected for the analysis of selenium content. By the end of the trial, at 42 days of age, 8 birds from each treatment were slaugthered (two males per pen) after 12 hour food deprivation. After evisceration, the breasts and thighs, with skin, were separated, packed in plastics bags and chilled during transport to the laboratory. The breast (*pectorals major*) and thigh (*gastrocnemius interna*) muscles were ground and divided into several samples for the determination of selenium and α-tocopherol at 0, 4, or 8 days during storage at 5°C. The α-tocopherol content of diets and meat was determined according to the EVS-EN 12822 European standard (EESTI STANDARD, 2000) by HPLC (Shimadzu, VP series) equipped with a diode-array detector.

At the end of the 5th week, samples of excreta were collected for the analysis of selenium content. On day 42 were used 8 birds from each treatment (two males per pen) to evaluate slaughter traits. Chickens were slaughtered after 12 hours of food deprivation, in order to eliminate the influence of outside factors on weight ratios

Analyses

Data were analyzed using SAS software [13] by ANOVA test which were appropriate for a randomized complete block design, and when significant differences ($P < 0.05$) were detected, means were compared post-hoc using the Duncan multiple range test. The results are expressed as means and their Standard Error (SE).

Table 1. Ingredients and chemical analyses composition of the starter and grower diets

Ingredients (g/kg)	**Starter**	**Grower**
Maize	557	300
Wheat	--	330
Soybean meal	370	300
Soybean oil	30	40
Fish meal	20	--
Limestone	10	--
Oyster shell	--	12
Dicalcium phosphate	5	15
Vitamin-mineral mix[1]	5	5
dl-methionine	1	1
Sodium chloride	2	2
Vitamin E (mg/kg)	--	75
Se (sodiumselenite/se-yeast) (mg/kg)[2]	--	0.3
Analyzed chemical composition (g/kg)	**Starter**	**Grower**
Dry matter	892.2	893.5
Crude protein	222.3	200.7
Fat	62.4	62.9
Fiber	36.1	35.6
Ash	61.7	57.0
Calcium	8.22	8.15
Phosphorus	5.48	5.57
Selenium (mg/kg)	0.53	(0.365, 0.362, 0.371 and 0.375)[3]
ME by calculation (MJ/kg)	12.78	12.91

[1]starter diet fed to birds from 0 to 20 days. [2]1% basal premix was made with the selenium products for mixing of dietary Treatments in grower phase. Selenium contained 1000 mg Se/kg and it was supplemented, individually or mixed (sodium selenite/se-yeast) to the diet mixture. Sodium selenite (Na_2SeO_3; SS) content was more than 98%. Se-enriched yeast (SY) provided per kg of diets: selenium 0.3 mg, calcium 0.75 mg, phosphorus 2.33 mg, sulfur 1.21 mg, potassium 3 mg, magnesium 0.94 mg, iron 0.074 mg, manganese 0.034 mg, copper 0.015 mg, zinc 0.107 mg. [3]T1, control diet = 3% SS; T2 = 2% SS + 1% SY; T3 = 1% SS + 2% SY; T4 = 3% SY. [4]Provides per kilogram of diet: vitamin A, 9,000 IU; vitamin D3, 2,000, IU; vitamin E, 18 IU; vitamin B1, 1.8 mg; vitamin B2, 6.6 mg; vitamin B3, 10 mg; vitamin B5, 30 mg; vitamin B6, 3.0 mg; vitamin B9, 1 mg; vitamin B12, 1.5 mg; vitamin K3, 2 mg; vitamin H2, 0.01 mg; folic acid, 0.21 mg; nicotinic acid, 0.65 mg; biotin, 0.14 mg; choline chloride, 500 mg; Fe, 50 mg; Mn, 100 mg; Cu, 10 mg; Zn, 85 mg; I, 1 mg; Se, 0.2 mg.

RESULTS

The growth performance was improved in male broilers fed diets containing SY when compared to birds fed SS diets (Table 2). Using organic selenium (Se-enriched yeast) in the regular diet significantly($P \leq 0.01$) increased the live weight of chickens. Also, significant differences in feed conversion ratio (FCR) were observed among the groups ($P \leq 0.05$). Broiler chickens fed 3% Se-enriched yeast (T4) diet had lowest feed conversion compared to others diets. Mortality rate were not affected ($P < 0.05$) by Se source or supplementation level in period of growth or trial. The mortality rate was numerically lowest for T3 and T4. Dietary replacement of inorganic selenium with organic form increased (P<0.05) the concentration of Se and α-tocopherol in breast and thigh muscles (Table 3). By replacing selenium source from SS to SY in diet of male broilers, the concentration of Se in excreta was decreased.

DISCUSSION

Our growth performance agrees with Payne and Southern [6] and Robert Upton *et al*. [8]. In a study by Robert Upton *et al*. [8], the effects of two type source of inorganic and organic Se sources (sodium selenite and Se-enriched yeast, combinational or alone) compared to control diet were assessed. They reported that the SY affected the performance of broilers. Body weight for broilers fed SY were increased in compared to no Se or SS treatments and the combination of SS and SY was not more effective than SY alone. Also, FCR improved with SY and SY+SS being superior to SS [8]. However, the present results do not agree with those of Yoon *et al*. [12], who reported that selenium supplementation did not influence (P < 0.05) the growth performance of broilers at 42 d of age. In their study, broilers were fed with corn-soy-based diets formulated to contain 0 (negative control), 0.1, 0.2, or 0.3 ppm Se from Seleno-Source AF (Se yeast A), 0.3 ppm of Se from Sel-Plex (Se yeast B), or 0.3 ppm of Se from sodium selenite. On the other hand, these findings in the indices are in agreement with the results of the study by Ryu *et al*. [14] who reported that feeding even higher concentrations (1 to 8 ppm) of dietary Se from an inorganic source did not affect the BW of broilers. Considering the use of Na_2SeO_3 alone in dietary supplementing and feeding these practical diets to broilers from 3 to 6 wk of age, no adverse effect was observe for Se on the growth performance of broiler chickens. The addition of vitamin E to diets with Se supplementation can be useful for improvement of performance or other studied traits. These results are in accordance with those stated by Choct *et al*. [15] who found that birds receiving organic Se in their diets had improved eviscerated weight, breast yield and reduced drip loss.

In present study, replacing SS by SY increase body weight gain, breast weight, and decrease FCR for male broiler chickens. It can be concluded that when inorganic Se replaced with Se-yeast, the better results can be observed for performance, if organic selenium in combination with vitamin E were supplemented in diets.

Choct *et al*. [15] found that an increasing supplementation rate of Se from 0.1 to 0.25 mg/kg increased the breast muscle selenium concentration from 0.232 to 0.278 mg/kg and both selenium source (organic and inorganic) and concentration significantly influenced ($P \leq 0.05$) the selenium content of the excreta at day 28. They reported that the amount of Se available for assimilation by the tissues was dependent on the source and concentration of the element while organic Se is deposited in the body tissues more efficiently than inorganic selenium. Inorganic selenium is passively absorbed from the intestine by a simple diffusion process, whereas organic selenium is actively absorbed through the amino acid transport mechanisms [16]. For this reason, inorganic Se (sodium selenite) was retained at a much lower concentration in muscle tissue, was less efficiently absorbed and was excreted at a higher rate than organic Se due to their different metabolic pathways. Echevarria *et al*. [17] and Downs *et al*. [18] stated that the Se concentration in several tissues, particularly in kidneys and liver, increased linearly with the increase of Se content of the diet.

Spears *et al*. [19] reported that broiler chickens fed 0.15 ppm Se-Methionine showed increased breast Se concentrations compared to those fed sodium selenite. Payne and Southern [6] observed that the increased Se concentration in breast muscle and blood plasma of broiler chickens fed diets supplemented with 0.3 ppm Se as Se-enriched yeast. Results found in the present study are in accordance with those stated by Ševčíková *et al*. [7] who found that Se and α-tocopherol retention increased in muscles of birds receiving organic Se in combination with 50 mg of vitamin E in their diets. It was reported that selenium as Se-enriched yeast has more efficient utilization than Se-alga, as indicated by the high Se concentration in breast and thigh muscle and low Se concentration in the excreta. The content of selenium in muscle may be influenced by the method of determination used (ICP, hydride system, atomic absorption spectrophotometry) in both trials.

Table 2. Effect of replacing inorganic Se by Se enriched yeast, an organic source on growth performance
Experimental diets[2]

Variable	T1	T2	T3	T4	SE	P[3]
d-1 BW (g)	44	45	46	44	0.35	NS
d-21 BW (g)	626.4	631.2	627.1	628.9	2.54	NS
d-42 BW (g)	2207.9^{c}	2239.6^{b}	2264.2^{b}	2315.1^{a}	10.71	**
F:G, g:g, 0 to 20 days	1.35^{a}	1.36^{ab}	1.36^{bc}	1.35^{c}	0.007	NS
F:G, g:g, 21 to 42 days	1.77^{a}	1.77^{ab}	1.74^{bc}	1.71^{c}	0.008	*
Mortality (%)	3	3	2	2		

^{a,b,c,d} btreatment means with different superscripts differ at $P < 0.05$. [1]Values are means of eight observations per treatment and their standard errors. [2]T1= diet with 3% SS; T2 = diet with 2% SS + 1% SY; T3 = diet with 1% SS + 2% SY; T4 = diet with 3% SY. [3] NS= P>0.05; *= P<0.05; **= P<0.01. SS = sodium selenite; SY = selenium enriched yeast; BW = body weight; F:G = feed:gain.

Table 3. Concentration of selenium and α-tocopherol in diets (mg/kg), breast and thigh muscles and excreta

	Experimental diets[2]					
Time of storage	**T1**	**T2**	**T3**	**T4**	**SE**	**P[3]**
Diet						
Selenium	0.35	0.36	0.37	0.36	0.004	NS
α-tocopherol	71.5	71.3	72.4	72.6	0.38	NS
Breast muscle						
Selenium	0.64^{c}	0.71^{c}	1.02^{b}	1.46^{a}	0.38	**
α-tocopherol	45.7^{c}	46.1^{c}	52.3^{b}	56.7^{a}	1.12	**
Thigh muscle						
Selenium	0.66^{c}	0.76^{c}	1.05^{b}	1.22^{a}	0.04	**
α-tocopherol	51.1^{b}	50.6^{b}	52.1^{ba}	54.2^{a}	0.69	*
Excreta selenium	1.17^{a}	0.93^{b}	0.65^{c}	0.46^{d}	0.05	**

^{a,b,c,d} Averages with different superscripts differ at P < 0.05. [1]Values are means of eight observations per treatment and their standard errors. [2]Treatments:T1= 0.3 SS; T2 = 0.2 SS + 0.1 SY; T3 = 0.1 SS + 0.2 SY; T4 = 0.3 SY of mg/kg. [3] NS= non significant; *= P<0.05; **= P<0.01.

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