Effect of Different Levels of Selenium Source on Productive Performance and Some Physiological Responses of Broiler Chicks under Desert C onditions

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ABSTRACT

This work aimed to study the effect of different levels of selenium source (inorganic - organic) on productive performance, physiological responses and blood constituents of broiler chicks under desert conditions. A total number of 240 broiler chicks, day-old sexed males Cobb 500 were randomly divided into eight equal treatments (30 chicks of each) which in turn were divided into 3 equal replicates, 10 chicks each. The 1st, 2nd, 3rd, 4th treatments (Tr INS1, Tr INS2, Tr INS3 and Tr INS4, respectively), chicks fed inorganic selenium at level of 0.35, 0.30, 0.40, 0.45 mg/kg diet, respectively. The 5th, 6th, 7th and 8th treatments (Tr ORS5, Tr ORS6, Tr ORS7 and Tr ORS8, respectively), chicks were fed mixture inorganic and organic selenium at level of (0.15+0.20), (0.12+0.18), (0.17+0.23), (0.19+0.26) mg/kg diet, respectively. The (Tr INS1) served as control group. The results showed that, FBW and BWG were significantly increased in broiler chicks of Tr ORS6, Tr INS4, Tr INS2 and Tr ORS8 groups as compared with broiler chicks of control group. Glutathione activity was significantly increased in the chicks fed organic selenium as compared to the chicks fed inorganic selenium groups. Meanwhile, malondialdehyde enzymes (MDA) was decreased ($P<0.05$) in the chicks fed mixture inorganic and organic selenium as compared to the chicks of control group. In conclusion, the delivery of mixture inorganic and organic selenium at level of 0.30 mg/kg (0.12 mg/kg diet inorganic selenium + 0.18 mg/kg diet organic selenium) diet to broilers is beneficial for growth performance without having negative effect on physiological responses.

Keywords: Broiler, Performance, Selenium source, Glutathione peroxidase, Malondialdehyde

INTRODUCTION:

Minerals are essential for broiler good health and productivity. Although minerals yield no energy, their presence is necessary for maintenance of certain physiological processes which are essential to life (Soetan *et al.*, 2010). Traditionally, trace minerals are supplemented in the form of inorganic salts, such as sulfates, oxides, and carbonates, to provide levels of minerals that prevent clinical deficiencies, allow the bird to reach its genetic growth potential, or both. Despite enormous advances in poultry production and technology, research into trace mineral nutrition has lagged behind other areas of nutrition (Bao *et al.*, 2007).In this respect, natural antioxidants play an important role in maintaining bird health, productivity, and reproductive characteristics. In general, an integrated antioxidant system has been described in avian tissues (Surai, 2002); and it has been suggested that the cell's first line of antioxidant defense is based on the activity of three enzymes: superoxide dismutase (SOD), glutathione peroxidase (GSH-Px) and catalase. In this context, GSH-Px has received only limited attention in relation to poultry production. Since the major form of GSH-Px is Se-dependent, the role of Se in animal nutrition has attracted considerable attention (Mahan, 1999). The primary function of GSH-Px enzymes is to detoxify hydrogen peroxide and to convert lipid hydroperoxides to nontoxic alcohols (Jenkinson *et al.,* 1982). Chan *et al.,* (1994) suggested that an increase Se content in tissue might not always be accompanied by a corresponding increase in GSH-Px activity. This implies an influence of dietary Se levels on the oxidative stability of skeletal muscle. Studying diets that have been supplemented with either sodium selenite and Se enriched yeast (Kuricova *et al.,* 2003; Choct *et al.,* 2004; Payne and Southern, 2005). It was found that organic selenium was deposited more effectively in broiler breast muscle than inorganic selenium. The use of organic trace minerals can improve intestinal absorption of trace elements as they reduce interference from agents that from insoluble complexes with the ionic trace elements (particularly selenite) (Van der Klis and Kemme, 2002) with uptake from the gastrointestinal tract of more than 90 % of selenomethionine compared to about 60 % of selenite (Stewart *et al*., 1987). organic source of selenium such as Se-enriched yeast was approved for use as a feed supplement in poultry diets (FDA, 2000).Therefore, this work aimed to study the effect of different levels of selenium source (organic - inorganic) on productive performance, some physiological responses and blood constituents of broiler chicks under desert conditions.

MATERIALS AND METHODES

This study was conducted in the South Sinai Research Station located at Ras Sudr area, South Sinai Governorate which is affiliated to Desert Research Center, Ministry of Agriculture and Land Reclamation, Egypt. The experiment started on August 2016 up to October 2016. Laboratory work was carried out in the laboratories compound of Desert Research Center.

Experimental design:

A total number of 240 broiler chicks, day-old sexed males Cobb 500 were obtained from a commercial hatchery. Chicks were randomly divided into eight equal treatments (30 chicks of each) which in turn were divided into 3 equal replicates, 10 chicks each. The 1st treatment (Tr INS1), chicks were fed a basal diet supplemented with the recommendation of inorganic selenium at level of 0.35 mg/kg diet according to the strain guide and serve as control group. The 2nd treatment (Tr INS2), chicks were fed inorganic selenium at level of 0.30 mg/kg diet. The 3rd treatment (Tr INS3), chicks were fed inorganic selenium at level of 0.40 mg/kg diet. The 4th treatment (Tr INS4), chicks were fed inorganic selenium at level of 0.45 mg/kg diet. The 5th treatment (Tr ORS5), chicks were fed organic selenium at level of 0.35 mg/kg diet (0.15 mg/kg diet inorganic selenium + 0.20 mg/kg diet organic selenium). The 6th treatment (Tr ORS6), chicks were fed organic selenium at level of 0.30 mg/kg diet (0.12 mg/kg diet inorganic selenium + 0.18 mg/kg diet organic selenium). The 7th treatment (Tr ORS7), chicks were fed organic selenium at level of 0.40 mg/kg diet (0.17 mg/kg diet inorganic selenium + 0.23 mg/kg diet organic selenium). The 8th treatment (Tr ORS8), chicks were fed organic selenium at level of 0.45 mg/kg diet (0.19 mg/kg diet inorganic selenium + 0.26 mg/kg diet organic selenium).

Experimental diets and management:

The chicks were given starter, grower, and finisher basal diets based on maize and soyabean meal. The period of each feeding phase and the composition of the experimental diets are given in Table (1).

Nutrient levels of the diets for broilers were based on the breeder recommendations guide Cobb 500 (2013). All chicks had free access to feed and water (*ad-libitum*) over the experimental period. Chicks in all treatments were kept under similar management conditions and subjected to vaccine and disease control during the experimental time.

Measurements:

Indoor climatic conditions

Daily indoor climatic conditions (ambient temperature (°C) and relative humidity %) were recorded during the experimental period using electronic digital thermo-hygrometer. The relationship between ambient temperature and relative humidity was termed as temperature-humidity index (THI) and calculated according to Marai *et al*., (2001) as in the following formula:

THI = db°C – [(0.31 – 0.31 × RH) × (db°C – 14.4)]; Where, db°C = dry bulb temperature and RH = relative humidity (%). The THI values were classified as absence of heat stress (<27.7), moderate heat stress (27.8-28.8), severe heat stress (28.9-29.9) and very severe heat stress (>30.0).

Thermo-respiratory responses:

Rectal temperature (RT), skin temperature (ST) and respiration rate (RR) were measured. Rectal temperature (°C) was measured by inserting clinical thermometer (2-3 cm) into the cloaca for one minute. Skin temperature (ST) was recorded using digital tele-thermometer. Respiration rate (breaths/minute) was measured by counting the body wall movements per one minute.

Broiler performance

Live body weight of chicks was weekly individually recorded, the average body weight gain was calculated, and the amounts of feed consumed were recorded. Values of feed conversion were calculated. The accumulative mortality rate was recorded.

Blood parameters:

Blood samples were withdrawn from six birds within each treatment at 6 weeks of age from jugular vein. The blood samples were collected into dry clean centrifuge tubes without anticoagulants. Serum was collected by centrifugation for 20 minutes at 3000 rpm and stored at –20 °C until analysis. The biochemical analysis of serum was carried out for quantitative determination of blood parameters by spectrophotometer (total protein, albumin, alanine transaminase, aspartic transaminase) according to Young (2001), serum superoxide dismutase (SOD) according to Nishikimi *et al*. (1972), serum glutathione peroxidase (GSH-Px) according to Patterson and Lazarow (1955), serum malondialdehyde enzyme (MDA) according to Draper and Hadley (1990) and thyroid hormones (free T_3 and T_4) according to Ellis and Ekins (1973). Determinations were done by using commercial kits produced by Diamond Laboratory, Inc. Globulin was calculated by the difference between total protein and albumin. The ratio of albumin to globulin was calculated.

***Selenium deposition*:**

Selenium deposition in breast and thigh were analyzed by using atomic absorption spectrophotometric method that was used for the determination of copper, zinc, chromium, cadmium, selenium and lead as described in Perkin Elemer catalogue of atomic absorption model 2380, according to Perkin Elemer, U.S.A. (1982).

European Production Efficiency Factor (EPEF):

EPEF was calculated as the following equation:

EPEF = (mean of body weight × livability (100 - mortality) divided by experimental period per day × feed conversion rate) multiplied by 100 (Kryeziu et al., 2018)

Statistical analysis:

Data were analyzed by the least square analysis of variance using the General Linear Model Procedure (SAS, 2004).

Significant differences among means were tested using Duncan multiple range test (Duncan, 1955). Mortality rate was analyzed by Chi square analysis.

RESULTS AND DISCUSSION

Productive performance of broiler chicks:

During the whole experimental period (1-6 weeks of age), final body weight (FBW) and body weight gain (BWG) were significantly (P<0.05) increased in broiler chicks of Tr ORS6, Tr INS4, Tr INS2 and Tr ORS8 groups as compared with broiler chicks of control group (Tr INS1). The present findings demonstrated that increasing selenium level from 0.35 to 0.45 mg/kg diet tend to increase FBW and BWG (Table 2**.** Concerning supplementation of inorganic selenium, at all supplementation levels of a mixture of organic and inorganic selenium tend to increase FBW and BWG (Table 2). Total feed intake (TFI) was increased (P<0.05) in broiler chicks of Tr ORS8 when compared to the broiler chicks of control group (Tr INS1) and the other treatments. While the group of Tr INS3 was significantly (P<0.05) recorded the less amount of TFI compared to the broiler chicks of control group (Tr INS1) and the other treatments. Chick of Tr INS3 had the lowest TFI followed by Tr ORS7 group and control group then the chicks of Tr ORS5. The highest TFI value was recorded for the chicks of Tr ORS8. Chicks of Tr INS4 and Tr INS2 had the better (FCR) in order with significant differences (P< 0.05) with those of chicks in Tr INS3 and control groups, respectively (Table 2). FCR was significantly (P<0.05) bettered in the chicks of Tr ORS6 followed by Tr INS4 and Tr INS2 groups when compared with control group and the other treatments. These results mean that the chicks of Tr ORS6 showed significantly improvement in FCR by 14.1, 15.4 and 12.2 % as compared to the chicks of control group, Tr INS3 and Tr ORS7, respectively. Remarkably, the exhibited trends of all studied parameters for organic treatments were nearly the same one of their counterparts of inorganic ones. However, it is worthy to mention that replacing part of inorganic selenium form with organic form resulted in improving the chicks' performance. At all studied levels of selenium where chicks received organic form, they exceeded their counterparts of inorganic selenium form in final body weight, body weight gain and total feed intake. Moreover, applying mixing of organic and inorganic selenium resulted in improving the feed conversion rate as compared with control group (Table 2).These results agree with the results of Upton *et al*. (2008) and Yang *et al*. (2012), they studied the effect of organic and inorganic selenium on broiler chick performance. They showed significant improvement by using organic selenium enriched yeast on broiler growth performance compared to inorganic selenium.

The improvement in growth performance of present study may be attributed to the fact that the organic form of selenium may be more available to the chick than the inorganic forms of selenium (Choct *et al*., 2004 and Yang *et al*., 2012). They suggested that the organic selenium was better absorbed than the inorganic source. The improvement in feed conversion ratio might be related to the significant improvement in the body weight gain or the effect of organic selenium on thyroid hormone activation which causes reduction in the energy requirement of broilers for maintenance, which consequently improved the feed utilization efficiency. As selenium deficiency depresses the growth of broilers by inhibiting hepatic 5′-deiodinaseactivity which causes lower plasma 3,5,3′-triiodothyronine concentration. Dietary selenium supplementation significantly increased plasma 3, 5, 3′-triiodothyronine concentration and improved growth performance (Naik, 2012).Finally, lowering selenium level (ration Tr INS2 and Tr ORS6) wither inorganic or organic forms triggered the potentiality of chicks to achieve better productive performance than their counterparts of other selenium rations which might need further studies to confirm these results.

The results of mortality rate are demonstrated in Figure (1). The results showed that the mortality rates did not significantly differ in all treatments of broiler fed different levels of inorganic or organic selenium. However, it can be noticed that mortality was decreased by organic selenium supplementation in the diets of broiler chicks (Tr INS2, Tr INS4, Tr ORS5, Tr ORS6, Tr ORS7 and Tr ORS8) groups as compared to the chicks of control group (Tr INS1). Similar results were observed by Choct and Naylor (2004), Peric *et al.* (2009), Tayeb and Qader (2012) and Kinal *et al*. (2012) They observed that mortality rate was not influenced by selenium supplementation broiler diets.

Indoor climatic conditions

The results of Indoor climatic conditions are represented in Table (4). The THI during the experimental period was ranged (26.2 to 29.7) the THI reveled that the bird were under severe heat stress according to Marai *et al*., (2001) during experimental time.

Thermo-respiratory responses of broiler chicks.

The results confirmed that rectal temperature (RT) was significantly ($P<0.05$) decreased in the chicks of groups Tr INS4 and Tr ORS8, while Tr INS3 and Tr ORS5 were significantly ($P<0.05$) higher in RT as compared to control group (Tr INS1) and the other treatment (Table 3). At the same time, skin temperature (ST) was significantly ($P<0.05$) increased in the broiler chicks of Tr ORS7 compared to control group. On the other side, the broiler chicks of Tr INS4, Tr ORS8 and control group (Tr INS1) were recorded significantly ($P<0.05$) the lower values of ST compared to the other treatments. The results of respiration rate (RR) showed that the broiler chicks of Tr INS2, Tr INS3, Tr INS4, Tr ORS5, Tr ORS6, Tr ORS7 and Tr ORS8 were significantly lower in the RR compared to control group (Tr INS1) by 9.7, 9.5, 13.4, 10.4, 9.4, 11.1 and 11.2 %, respectively. Seemingly, these results might reveal the importance of increasing the supplementation levels of inorganic or organic selenium in broiler diets to mitigate the severe heat stress effect on broiler chicks. The relatively low of RR in the treated chicks may be attributed to higher respiration efficiency as a result of increasing the depth of air changing rather than increasing their number (Zaher, 2021).

Total protein and its fractions parameters of broiler chicks

Total protein and albumin concentrations were increased ($P<0.05$) in the chicks fed organic selenium supplementation particularly when the level of organic selenium increased in the diets (Tr ORS5, Tr ORS6, Tr ORS7 and Tr ORS8) as compared to the chicks fed inorganic selenium (control group (Tr INS1), Tr INS2, Tr INS3 and Tr INS4). The higher values of total protein and albumin concentration were observed in the chicks of Tr ORS8 and Tr ORS7 compared with control group (Tr INS1) and the other treatments (Table 4).

On the other hand, the chicks of Tr ORS6 significantly ($P<0.05$) recorded the lowest value in globulin concentration compared to the other treatments. Although, A/G ratio was significantly increased in the chicks fed different levels of organic selenium when compared to the chicks fed inorganic selenium.

These results are agreed with the results of Zaher (2021), they found that the concentrations of total protein, albumin and A/G ratio were significantly increased linearly as the dietary of organic selenium increased. However, Attia *et al.* (2010) and Okunlola *et al.* (2015) pointed out that selenium supplemented level (0.15 to 0.30 mg Se/kg diet from sodium selenite or Se-yeast) in diet of broiler chicks did not significantly affect the concentration of albumin and total protein. The obtained results of organic selenium supplementation may regulate cholesterol biosynthesis where it was essential for the formation of bile acid which can promote the excretion of excess selenium absorbed and some toxic compounds, consequently the liver becomes healthy and more active. Also, the increase in liver activity by selenium supplementation may facilitate the synthesis of whole albumin and most of globulin formed intrahepatically (Sorensen *et al*. 1982). The increase in liver activity may interpret to some extent, the increase of serum total protein, albumin and globulin. Since the globulin was statistically affected by selenium supplementation. It may be concluded that the medication property of selenium does not interfere with the development of immunity (Zaher, 2021).

Liver functions of broiler chicks

The results of liver enzymes are illustrated in Figures (2 and 3). The chicks fed diets containing different levels of inorganic selenium have recorded significant high values of alanine transaminase (ALT) comparing with the chicks fed different levels of organic selenium in this study, which mean that the chicks fed organic selenium were significantly ($P<0.05$) lower in the ALT concentration. Similar trend was observed with the results of serum aspartic transaminase (AST). The higher values of ALT and AST observed with chicks received 0.45 mg inorganic selenium /kg diet (Tr INS4) by 81.6 and 58.2 %, respectively) as compared to control group (Tr INS1). On the other hand, the lower value of ALT was recorded with chicks of group Tr ORS5 by 40.0 % as compared to control group, meanwhile, the lower value of AST was noticed in the chicks of Tr ORS8 by 41.7 % as compared to control group (Tr INS1). The results are agreed with the results of Peric *et al*. (2009) and Zaher (2021), they concluded that both of ALT and AST enzymes reduced significantly with treatment supplemented with organic selenium. According to Mezey (1976) AST and ALT enzymes increased in serum when the hepatic cells are damaged or their membrane disrupted, the present results of transaminase activities confirmed that there was some alter of hepatic cells due to the addition of inorganic selenium with high level in poultry diets (Tr INS3 and Tr INS4). The significant reductions in both ALT and AST activities as a result of supplementation of organic selenium might be due to the fact that the organic selenium causes a less oxidative damage to liver in the present findings.

Thyroid hormones

The results of triiodothyronine hormone (T_3) were increased ($P<0.05$) in the chicks of Tr INS2, Tr INS3, Tr INS4, Tr ORS7 and Tr ORS8 by 52.8, 112.6, 83.9, 40.2 and 68.9 %, respectively as compared to the chicks of control group (Tr INS1) (Figure 4). Generally, the obtained results indicated that the T3 concentration was increased as the level of inorganic or organic selenium increased in the diets. Nevertheless, T_3 hormone concentration in the chicks fed inorganic selenium was significantly ($P<0.05$) higher than those fed organic selenium. The results of current experiment noticed that the thyroid hormones were increased in the chicks received inorganic or organic selenium by the increase of the level of addition. These results are in agreement with results obtained by Selim *et al.* (2015) and Zaher (2021), they showed that increased values of T_3 hormone might be due to increasing supplemental selenium levels. Tri-iodothyronine hormone is a main hormone that regulates growth by controlling the body's energy and protein anabolism (Arthur *et al.*, 1999). Also, they noted that selenium may protect the thyroid gland from oxidative damage due to any excess H_2O_2 produced during thyroid hormone synthesis or exposed to severe heat stress. However, T_3 hormone in this study was significantly ($P<0.05$) decreased in the chicks received organic selenium than those fed inorganic selenium.

Regarding thyroxine hormone (T_4), it was increased ($P<0.05$) in the chicks of Tr INS2 compared to the chicks in control group (Tr INS1), Tr ORS5, Tr ORS6 and Tr ORS7 (Figure 4). However, no significant differences were observed among treatments fed organic selenium in the concentration of T_4 hormone. These results disagree with the results of Upton *et al*. (2008), who reported that the serum thyroxine and triiodothyronine levels were higher in birds that are given diet free selenium when compared to those supplemented with seleno-yeast.

Antioxidative parameters

Superoxide dismutase activity was decreased ($P<0.05$) in the chicks of control group (Tr INS1) as compared to the chicks in groups Tr INS2, Tr INS3 and Tr INS4. However, chicks fed organic selenium showed insignificant increased SOD activity as compared to the chicks of control group (Tr INS1). Knowing that, the treatments supplemented with inorganic selenium were recorded higher values in SOD compared with those supplemented with organic selenium (Table 5).

These results disagree with the results of Mikulski *et al*. (2009), as they indicated that SOD activity was significantly higher in the chicks fed organic selenium than in the chicks fed inorganic selenium (chicks fed 0.35 mg inorganic selenium /kg diet). Meanwhile, glutathione activity (GSH) was significantly increased in the chicks fed organic selenium (Tr ORS5, Tr ORS6 and Tr ORS7) as compared to the chicks fed inorganic selenium groups (control group Tr INS1, Tr INS2 and Tr INS3).

These results agree with the results of Payne and Southern (2005), as they observed that dietary organic selenium supplementation increased the plasma GSH-Px activity in the broiler chicken which played a vital role in the detoxification of hydrogen peroxide and protect the cell from injury caused by peroxides. The basic function of GSH-Px is elimination of excessive peroxide and hydrogen peroxides of fatty acids resulting from oxidative elimination of lipids (De Almeida *et al*. 2012). These results indicate that the effects of organic selenium on enhancing body oxidation resistance were superior to those of inorganic selenium.

Concerning the MDA results, they were decreased significantly ($P<0.05$) in the chicks of Tr ORS5, Tr ORS6, Tr ORS7 and Tr ORS8 by 2.2, 3.5, 2.1 and 2.6 %, respectively as compared to the chicks of Tr INS1. Also, they significantly decreased in the chicks of Tr INS2 and Tr INS4 by 2.1 and 2.1 %, respectively as compared to the chicks of Tr INS1. But in general, the chicks fed diet containing inorganic selenium were higher in serum MAD concentration when compared to those fed diet contained organic selenium.

These results agreed with the results of (Chen *et al.*, 2014), who reported that the MDA value was significantly lower in chicks fed organic selenium than that fed of inorganic selenium. In general, organic selenium may improve antioxidant status of broiler chickens. Glutathione peroxidase (GSH-PX) is a seleno-enzyme can slow down and prevent oxidative reactions by controlling free radicals' formation from old peroxides (Arai *et al.*, 1994). Malondialdehyde (MDA) level known as a marker of oxidative stress and antioxidant status. Free radicals generate the lipid peroxidation process in an organism. Malondialdehyde is one of the final products of polyunsaturated fatty acids peroxidation in the cells, an increase in free radicals causes rising of MDA production (Gawel *et al.*, 2004). These finding agreed with (Hashemipour *et al.*, 2013; and Placha *et al.*, 2014).

Selenium deposition in breasts and thighs of broiler chicks

The selenium concentration in the breast muscles was significantly decreased in the chicks of Tr ORS7 and Tr ORS8 as compared to control group (Tr INS1) and the other treatments. The lowest value was observed in the chicks of Tr ORS7 and it decreased by 63.4, 65.1, 71.2, 68.4, 71.9 and 65.1 % as compared to the chicks of Tr ORS6, Tr ORS5, Tr INS4, Tr INS3, Tr INS2 and control group (Tr INS1), respectively (Figure 5).

In the same context, the results generally appeared that the concentration of selenium in breast muscles was increased in broiler chicks fed inorganic selenium than those fed organic selenium.However, selenium concentration in the thigh meat was significantly decreased in the chicks of Tr ORS8 by 39.7, 45.0, 45.6, 45.0, 45.0 and 39.7% as compared to the chicks of Tr ORS7, Tr ORS6, Tr INS4, Tr INS3, Tr INS2 and control group (Tr INS1), respectively (Figure 5). Meanwhile, no significant effect is recorded among the chicks of Tr ORS8 and Tr ORS5 in selenium concentration in thigh meat.

The recommendation for the daily intake of Se by the FAO (2002) is 0.065 and 0.055 mg for men and women aged 19 to 65 years old, respectively. Dietary supplementation, favored the deposition of organic selenium in the breast, may be due to the high capacity of selenium to be incorporated into muscles.

The increase in selenium concentration in meat due to dietary selenium supplementation agrees with findings presented by Sevcikova *et al*. (2006), Dlouha *et al*. (2008) and Skřivan *et al*. (2008 a, b). Inorganic selenium was retained at a much lower concentration in muscle tissue that was less efficiently absorbed and was excreted at a higher rate than organic selenium due to their different metabolic pathways (Mahan and Parrett, 1996). In the present results, the decrease in selenium concentrations in the meat of chicks which are fed organic selenium may be supported by the results of glutathione peroxidase which recorded the highest values as compared to the chicks which fed inorganic selenium and the results of malondialdehyde enzymes which recorded the lowest values (Figur5) and this might indicate that organic selenium improve the efficiency of selenium in decreasing body oxidation as a result of improving antioxidant status.

European Production Efficiency Factor (EPEF):

Values of EPEF of broiler chicks as affected by selenium supplementation in the diets during the whole experimental period are presented in Table (6). The presented results clearly that EPEF increased in the chicks of Tr ORS6 as compared to control group (TR INS1) and other treatments. These results were due to the improving of final body weight and improved feed conversion by organic selenium supplementation.

CONCLUSION

The delivery of organic Se at level of 0.30 (0.12 mg/kg diet inorganic selenium + 0.18 mg/kg diet organic selenium, (Tr ORS6), to broilers is beneficial for growth performance without having negative effect on physiological responses, blood constituents and selenium deposition in the meat of broiler chicks.

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Table 1: Composition and calculated analysis of experimental diets of broiler chicks (Cobb 500).

Ingredients	Starter diet (1–10 day)	Grower diet (11 –22 day)	Finisher diet (23 – 42 day)
Ground yellow corn (8.5%)	57.55	61.08	61.54
Soybean meal (44%)	26.51	25.39	23.50
Corn gluten meal (60%)	10.00	7.41	7.00
Soybean meal oil	1.47	2.70	4.20
Dicalcium phosphate	1.91	1.16	1.64
Limestone	1.30	1.15	1.10
Vitamins premix*	0.10	0.10	0.10
Minerals premix*	0.30	0.30	0.30
Sodium chloride (NaCl)	0.20	0.20	0.20
Choline chloride	0.094	0.094	0.094
DL-methionine	0.19	0.15	0.13
L-lysine-HCl	0.38	0.27	0.20
Calculated analysis**	100	100	100
Crude protein (%)	22.00	20.00	19.00
ME. cal/Kg diet	3035.1	3018.0	3180.0
Calcium (%)	0.90	0.85	0.82
Available Ph. (%)	0.46	0.43	0.40
Lysine (%)	1.34	1.18	1.06
Methionine (%)	0.60	0.52	0.48
Methionine + Cystin (%)	0.99	0.88	0.83

*Each 3Kg of vitamin and minerals mixture contain: Vit. A 10.000.000 IU, Vit. D_3 2.000.000 IU, Vit. E 10.000 mg, Vit. K_3 1.000 mg Vit. B_1 1.000 mg, Vit. B_2 5.000 mg, Vit. B_6 1.500 mg, Vit B_{12} 10 mg, Niacin 20.000 mg, Pantothenicacid 10.000 mg, Folicacid 1.000 mg, Biotin 50 mg, Choline chloride 500.000 mg, Copper 4.000 mg, Iodine 300 mg, Iron 30.000 mg, Manganese 60.000 mg, Zinc 50.000 mg, Cobalt 100 mg and Selenium 100 mg. **According to NRC (1994).

Table 2: Effect of different levels of inorganic or organic selenium in the diets on final body weight, body weight gain, total feed intake and feed conversion ratio of broiler chicks at 6th weeks of age.

Items	FBW (g)	BWG (g)	TFI (g)	FCR
Tr INS1	1773.80^{bc}±48.67	1682.50^{bc}±48.42	3150.06^{d}±13.24	1.91^{a}±0.05
Tr INS2	2066.40^{a}±51.42	1974.48^{a}±51.29	3366.95^{b}±13.38	1.73^{bc}±0.04
Tr INS3	1678.10^{c}±51.39	1586.38^{c}±51.35	2996.87^{e}±9.53	1.94^{a}±0.06
Tr INS4	2079.82^{a}±55.47	1988.57^{a}±55.63	3339.23^{b}±12.02	1.71^{bc}±0.04
Tr ORS5	1889.17^{b}±48.26	1797.45^{b}±48.11	3165.16^{d}±11.88	1.79^{abc}±0.04
Tr ORS6	2083.17^{a}±50.11	1991.97^{a}±50.21	3220.78^{c}±6.36	1.64^{c}±0.04
Tr ORS7	1819.31^{bc}±52.49	1728.10^{bc}±52.67	3149.99^{d}±11.37	1.87^{ab}±0.06
Tr ORS8	2048.79^{a}±56.29	1957.59^{a}±56.40	3413.99^{a}±9.45	1.78^{abc}±0.05

Tr INS1=control group; FBW = Final body weight; BWG = Body weight gain; TFI = Total feed intake; FCR = Feed conversion ratio.

a, b, c, d Means bearing different superscripts within the same column are significantly different (P<0.05).

Table 3: Indoor ambient temperature, relative humidity and temperature-humidity index throughout experimental period under conditions of South Sinai, Egypt.

	AT(0C)	RH(%)	THI
Minimum	28.1	31.3	26.2
Maximum	33.9	55.3	29.7

AT= ambient temperature, RH= relative humidity, THI= temperature humidity index.

Table 4: Effect of different levels of inorganic or organic selenium in diets on thermo-respiratory responses of broiler chicks

Items	RT (°C)	ST (°C)	RR (breaths/minute)
Tr INS1	41.68^{ab}±0.09	40.37^{c}±0.07	85.53^{a}±1.14
Tr INS2	41.64^{ab}±0.08	40.48^{abc}±0.08	77.22^{b}±2.23
Tr INS3	41.86^{a}±0.07	40.61^{ab}±0.08	77.33^{b}±2.29
Tr INS4	41.54^{b}±0.06	40.31^{c}±0.08	74.04^{b}±1.96
Tr ORS5	41.84^{a}±0.11	40.62^{ab}±0.08	76.55^{b}±1.69
Tr ORS6	41.64^{ab}±0.06	40.41^{bc}±0.07	77.48^{b}±1.56
Tr ORS7	41.80^{ab}±0.09	40.70^{a}±0.07	76.00^{b}±1.94
Tr ORS8	41.56^{b}±0.07	40.36^{c}±0.05	75.88^{b}±1.85

Tr INS1=control group ;RT =Rectal temperature; ST = Skin temperature; RR = Respiration rate.
a, b, c Means bearing different superscripts within the same column are significantly different (P<0.05).

Table 5: Effect of different levels of inorganic or organic selenium in diets on serum total protein, albumin, globulin and albumin globulin ratio of broiler chicks

Items	Total protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)	A/G ratio
Tr INS1	5.08^{bc}±0.08	1.50^{d}±0.06	3.58^{ab}±0.07	0.42^{c}±0.19
Tr INS2	5.12^{bc}±0.09	1.45^{d}±0.05	3.67^{a}±0.11	0.40^{c}±0.02
Tr INS3	4.88^{c}±0.05	1.47^{d}±0.06	3.42^{ab}±0.04	0.43^{c}±0.01
Tr INS4	4.57^{d}±0.10	1.27^{d}±0.04	3.30^{b}±0.07	0.38^{c}±0.10
Tr ORS5	5.20^{b}±0.10	1.82^{c}±0.16	3.38^{ab}±0.15	0.55^{b}±0.07
Tr ORS6	5.28^{b}±0.08	2.28^{b}±0.08	3.00^{c}±0.11	0.77^{a}±0.06
Tr ORS7	5.95^{a}±0.08	2.48^{ab}±0.05	3.47^{ab}±0.06	0.72^{a}±0.01
Tr ORS8	6.00^{a}±0.06	2.55^{a}±0.06	3.45^{ab}±0.07	0.74^{a}±0.03

Tr INS1=control group ; A/G ratio =albumin globulin ratio.
a, b, c, d Means bearing different superscripts within the same column are significantly different (P<0.05).

Table 6: Effect of different levels of inorganic or organic selenium in the diet on serum superoxide dismutase, glutathione peroxidase and malondialdehyde enzymes of broiler chicks

Items	SOD (u/ml)	GSH (nmol/ml)	MDA (nmol/ml)
Tr INS1	6.73^{d}±0.17	23.33^{c}±0.42	31.41^{a}±0.25
Tr INS2	7.81^{ab}±0.12	23.33^{c}±0.42	30.75^{bc}±0.07
Tr INS3	8.00^{a}±0.07	19.67^{d}±0.49	31.30^{ab}±0.42
Tr INS4	7.70^{abc}±0.24	25.83^{b}±1.24	30.75^{bc}±0.10
Tr ORS5	7.20^{d}±0.07	26.83^{b}±0.96	30.70^{bc}±0.15
Tr ORS6	7.55^{bcd}±0.14	32.67^{a}±0.67	30.31^{c}±0.16
Tr ORS7	7.38^{bcd}±0.07	32.83^{a}±0.60	30.73^{bc}±0.09
Tr ORS8	7.35^{cd}±0.14	25.17^{bc}±0.83	30.58^{c}±0.13

Tr INS1=control group ; SOD = Superoxide dismutase; GSH = Glutathione peroxidase; MDA =Malondialdehyde.
a, b, c, d Means bearing different superscripts within the same column are significantly different (P<0.05).

Table 7: Effect of different levels of inorganic or organic selenium on the production number of broiler chicks

Items	FBW (g)	Livability (%)	Exp. period (day)	FCR	EPEF
Tr INS1	1773.8	93.34	42	1.91	206
Tr INS2	2066.4	96.67	42	1.73	274
Tr INS3	1678.1	96.67	42	1.94	199
Tr INS4	2079.82	93.34	42	1.71	270
Tr ORS5	1889.17	96.67	42	1.79	242
Tr ORS6	2083.17	96.67	42	1.64	292
Tr ORS7	1819.31	96.67	42	1.87	223
Tr ORS8	2048.79	96.67	42	1.78	264

Tr INS1=control group; FCR = feed conversion ratio

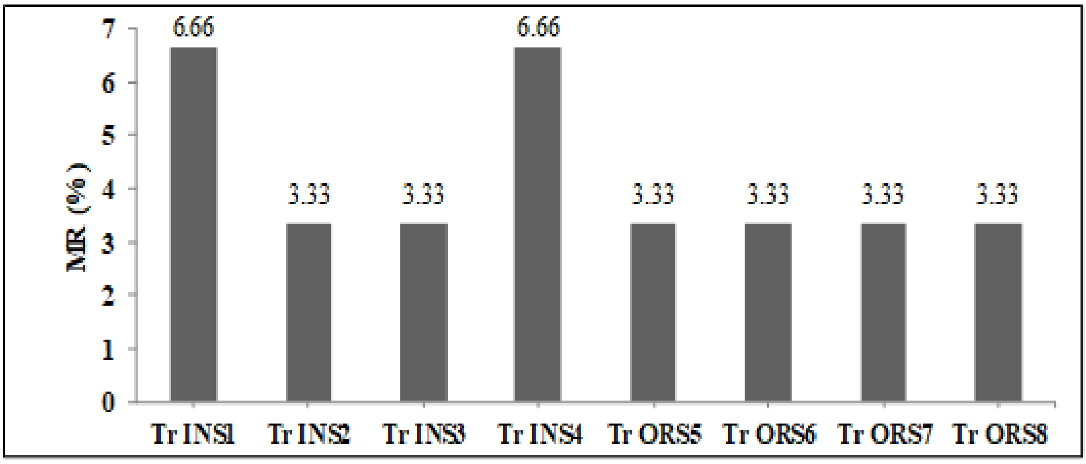

Figure 1: Effect of different levels of inorganic and organic selenium on mortality rate of broiler chicks

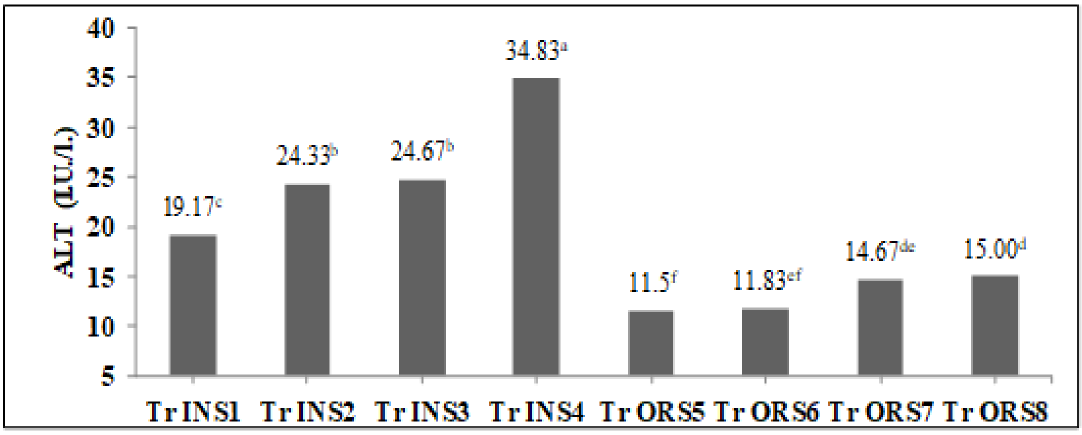

Figure 2: Effect of different levels of inorganic or organic selenium in the diets on serum alanine transaminase (ALT) of broiler chicks

Tr INS1=control group ; ALT = alanine transaminase

a, b, c, d, e, f Means bearing different superscripts are significantly different (P<0.05).

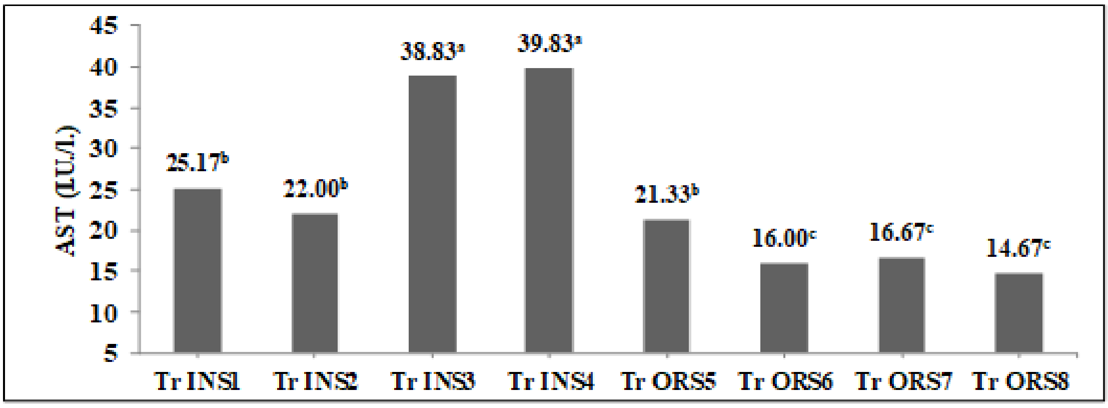

Figure 3: Effect of different levels of inorganic or organic selenium in the diets on serum aspartic transaminase (AST) of broiler chicks.

Tr INS1=control group AST = aspartic transaminase

a, b, c Means bearing different superscripts are significantly different (P<0.05).

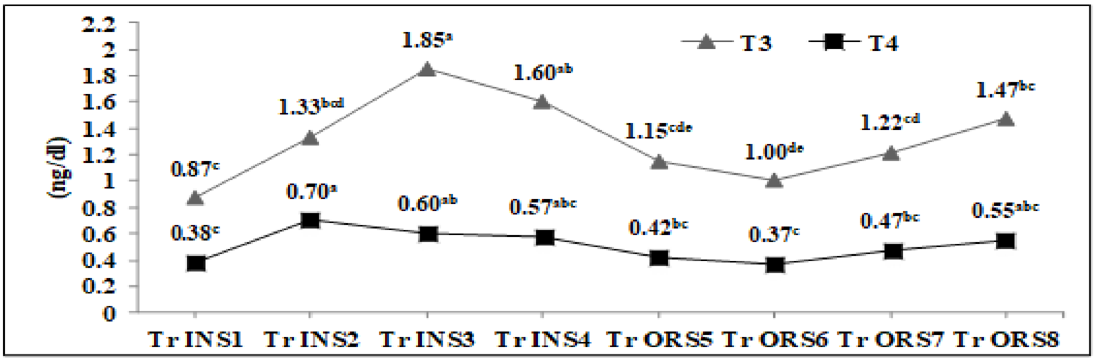

Figure 4: Effect of different levels of inorganic or organic selenium in the diets on thyroid hormones of broiler chicks

Tr INS1=control group ;T_3 = triiodothyronine hormone; T_4 = thyroxine hormone.

a, b, c, d, e Means bearing different superscripts are significantly different (P<0.05).

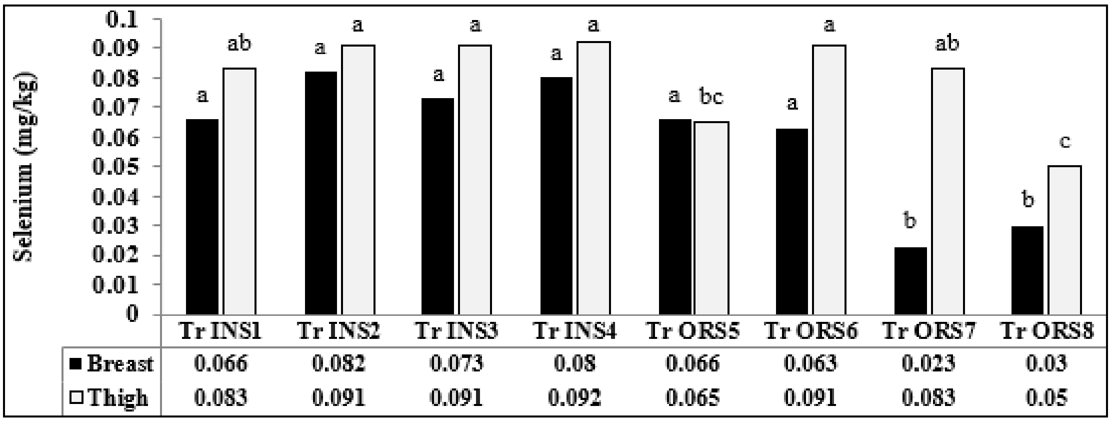

Figure 5: Effect of different levels of inorganic or organic selenium in the diets on the selenium deposition in the breast and thigh meat of broiler chicks

تأثير استخدام مستويات مختلفة من مصدر السيلينيوم على الأداء الإنتاجي وبعض الاستجابات الفسيولوجية لدجاج التسمين تحت الظروف الصحراوية

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الملخص العربي

تهدف الدراسة إلى استخدام مستويات مختلفة من مصدر السيلينيوم (معدني – عضوي) على الأداء الإنتاجي والاستجابات الفسيولوجية لدجاج التسمين تحت الظروف الصحراوية. استخدم فى هذه الدراسة عدد240 كتكوت تسمين عمر يوم ذكور من دجاج الكب 500 ووزعت عشوائيا إلى ثماني مجموعات متساوية (30 كتكوت/معاملة) وقسمت كل معاملة لثلاثة مكررات متساوية (10 كتكوت /مكررة). المعاملات الأولى والثانية والثالثة والرابعة غذيت الكتاكيت على السيلينيوم المعدنى بمستويات 0.35 و0.30 و0.40و 0.45 ملجم /كجم عليقة ، على التوالى. بينما المعاملات الخامسة والسادسة والسابعة والثامنة غذيت الكتاكيت على خليط السيلينيوم العضوى والمعدني بمستويات (0.20+0.15),(0.18+0.12) , (0.23+0.17) , (0.26+0.19) ملجم /كجم عليقة ، على التوالى. المعاملة الأولى هى الكنترول. أظهرت النتائج أن هناك زيادة معنوية فى وزن الجسم النهائى والزيادة فى وزن الجسم فى كتاكيت المعاملات السادسة والرابعة والثانية والثامنة مقارنة بالمجموعة الأولى (الكنترول). زاد معنويا نشاط إنزيم الجلوتاثيون فى المجموعات التى تغذت على مخلوط من السيلينيوم المعدني والعضوي مقارنة بالمجموعات التى تغذت على السيلينيوم المعدني. على العكس انخفض إنزيم المالون داي ألدهيد فى المجموعات التى تغذت على مخلوط من السيلينيوم المعدنى والعضوي مقارنة بالمجموعة الكنترول. تخلص الدراسة إلى أن استخدام مخلوط السيلينيوم العضوي والمعدني بتركيز 0.30ملجم /كجم عليقة كان مفيدا لأداء النمو بدون أي تأثيرات سلبية على الاستجابات الفسيولوجية لدجاج التسمين.

الكلمات الاسترشادية: دجاج التسمين، السيلينيوم العضوي، الجلوتاثيون بيروكسيديز، المالون داي ألدهيد