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EFFECT OF DIETARY ORGANIC SELENIUM ON PRODUCTIVE PERFORMANCE OF BROILER CHICKENS UNDER SUMMER CONDITIONS

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ABSTRACT: This work was conducted to evaluate the effect of dietary organic selenium (OR-Se) supplementation on growth performance, carcass traits, nutrient digestibility, blood metabolites, and antioxidant capacity of broiler chicks that reared in a high temperature environment. A total number of 320 one-day old unsexed chicks (Cobb-500) were raised during summer season under temperature ranged between 29.9 to 33.3 °C. Birds were randomly assigned to four treatment groups of 80 chicks each, with four replicates each of 20 chicks, kept in floor pens. The 1st group (T1) was fed basal diet, while the 2nd, 3rd and 4th groups (T_2, T_3, and T_4) were fed diets supplemented with 0.3, 0.6 and 0.9 mg OR-Se/kg diet, respectively. The obtained results indicated that, groups supplemented with 0.6 and 0.9 mg OR-Se (T_3 and T_4) significantly improved growth parameters (body weight, body weight gain, feed conversion ratio), and nutrients digestibility. Also, these groups had higher ($P< 0.05$) carcass weight and lower ($P< 0.05$) abdominal fat. Besides, blood parameters including red blood cells, haemoglobin and haematocrit concentrations of chicks in these groups were clearly increased in comparison with chicks (T_2) or the control group (T_1). Furthermore, adding OR-Se to broiler diets statistically enhanced lipid profile, liver enzymes, kidney function, and antioxidant activity under high temperature environment. It could be concluded that dietary supplementation with OR-Se (0.6 and 0.9 mg/kg diet) had a positive effects on productive performance of broilers by improving growth performance, digestibility of nutrients, blood metabolites, and antioxidant capacity of broiler chickens practically under summer conditions compared to the others in the groups.

Keyword: broiler, stress, selenium, growth, antioxidant

INTRODUCTION

Continuous genetic selection in broiler chickens for better feed efficiency, fast growth and rearing under intensive production system that leads to chicks become more vulnerable to environmental stressors such as heat stress (HS). In addition that, chicks have feather cover and do not have sweat glands make them incapability to reduce their body temperature under high temperatures than optimal conditions (Hu *et al*., 2021). During summer season of tropical and subtropical regions especially in open houses, exposing to high ambient temperatures than optimal ranges cause deleterious influences on the physiological status and growth performance of stressed chicks. While HS induced oxidative damage, that impaired productive performance (Tallentire *et al*., 2016; Gozalez-Reves *et al*., 2020). It can change the physiological biochemistry interaction of birds that can reduced feed consumption and impaired feed efficiency while leading to poor growth performance (He *et al*., 2020; Gozalez-Reves *et al*., 2020). Therefore under a high temperature environment, mitigating measures like antioxidant feed additives are affecting in production of commercial broilers to improve or maintain the optimum growth performance and carcass traits (Van Hieu *et al*., 2022).

Trace minerals are important to maintenance of homeostasis, increasing energy, protein, amino acids and calcium levels to treat nutrient deficiencies and reducing the destructive effects on chickens under HS conditions (Alagawany *et al.,* 2021; Kuttappan *et al*., 2021). Selenium (Se) is a vital essential component of enzymes and selenoproteins that can provide as antioxidative, antiflammatory, antiviral and antibacterial activity in biological systems (Pecoraro *et al*., 2022). It contributes in carbohydrate, protein and lipid metabolism and is necessary for enough appetite to avoid organs damage under unfavorable conditions which resulted in improved broiler performance aspects (Zhang *et al*., 2020). It is concerned in the exterior and selenoproteins synthesis and has an important function of thyroid hormones production which acting an essential role in metabolism and growth control. It is presence in approximately 25 selenoproteins involved in the multiple biological and physiological processes in the body requiring sufficient amounts of Se (Surai and Kochish, 2019).

There are two main forms of Se, the first is organic form, which present in animal and natural plant tissues include selenocysteine, selenomethionine and Se enriched yeast, and the second is inorganic form include selenate, selenite and selenide (Nabi *et al.,* 2020). Dietary supplementation with green Nano-selenium had positive effect on growth performance, immunity and antioxidant status of heat-stressed broilers (Dukare *et al*., 2020). Se enriched yeast as organic form used in heat-stressed poultry is more effective and less toxic than inorganic form (Woods *et al.*, 2021). Recently, dietary organic selenium (OR-Se) supplementation (0.4 up to 1mg/kg) could be alleviating the deleterious effects of HS on immunity, productive performance, livability and physiological status of chicks (Calik *et al*. 2022; Abbas *et al*., 2022). Therefore, this study aimed to investigate the impact of OR-Se as a feed additive in broiler diets under hot summer conditions on growth performance, carcass traits, nutrient digestibility, blood metabolites and antioxidant status.

MATERIAL AND METHODS

The current study was conducted in the poultry house, Kazan State Academy of Veterinary Medicine, Kazan, Russia. The study on broiler chickens was approved by the ethical committee of Kazan State Academy of Veterinary Medicine, Russia, following the recommendations of the Russian Research and Technological Institute of Poultry Breeding in Russia (Egorov *et al*., 2021). A total number of 320 unsexed Cobb 500 chicks one-day old (42.63±1.03g) were used during the experimental period (5 weeks). Chicks were reared in open-sided house (summer, 2022) and placed in floor pens covered with wood shavings litter. Chicks were weighed and randomly distributed into four treatment groups with four replicates. Each replicate contained 20 chicks allocated in floor pens (2.5 m^2 floor area).The 1st group (T_1) was the control group fed on basal diet without any additives, while the 2nd, 3rd and 4th groups (T_2, T_3 and T_4) were fed the basal diets (starter and finisher) supplemented with 0.3, 0.6 and 0.9 mg organic selenium (OR-Se) per kg diet, respectively. OR-Se was derived from yeast *S. cerevisiae* in product ALKOSEL® R397, Lallemand Inc., United Kingdom. All birds were provided with feed and water *ad libitum* for the whole experimental period (35 days). Uninterrupted light was ensured during the first 3 days, and then birds were exposed to 23 h of light and 1 hour of darkness per day. During the whole experimental period, the ambient temperatures and relative humidity were recorded daily every 2 hours (Figure1). Chicks received common starter (1–3 weeks of age) and finisher (3-5 weeks of age) diets that met the recommendations of Cobb-500 guideline (Cobb-Vantress, 2020). Diet composition for starter and finisher are showed in Table (1). The chemical composition was determined according to the Association of Official Analytical Chemists (AOAC, 2005).

Growth parameters

Live body weight (BW) and feed intake (FI), were recorded weekly per pen, FI was adjusted for mortality. Body weight gain (BWG) and feed conversion ratio (FCR) were calculated, while FCR was determined based on FI divided by BWG.

Carcass traits

At the end of the experiment (5 weeks of age), birds were fasted for 12 hours, two chicks were randomly selected from each pen (8 chicks/treatment) for slaughtering to perform some carcass characteristics.

The weights of the dressed carcass, internal organs (gizzard, heart, liver, and spleen) and abdominal fat were determined and presented as a percentage of BW.

Nutrient digestibility

At the end of the experiment (5 weeks of age), 12 chicks from each treatment (3 birds/replicate) were housed in separate metabolic cages for 5 days. Birds were given the experimental diets for 5 days, in which quantities of feed intake and excreta were determined daily. Excreta were sprayed with 1% boric acid to eliminate nitrogen loss due to possible ammonia release. The proximate analyses of feed and dried excreta were performed according to AOAC (2005). Nitrogen was determined by separating the fecal protein fraction in excreta samples (Jakobsen *et al*, 1960).

Hematological and biochemical measurements

At 5 weeks of age, three birds per pen were selected at random and blood samples were collected in two blood sterile tubes with or without heparin (Tube A and B respectively) from the wing vein. In tube A, for measurements, total red blood cells (RBC), leukocytes count were determined by a hemocytometer method (Campbell, 1995). Hemoglobin (Hb) and haematocrit (Hct) concentration were estimated by cyanomethemoglobin technic (Eilers, 1967) and microhematocrite centrifuge (Daice and Lewis, 1991), respectively.

Blood samples in tube B (non-heparinized tubes) were centrifuged at 3,000 rpm for 15minutes and serum was separated immediately after, and then stored at -20°C until further analysis.

Total protein (Total-P), Albumin (Alb.), globulin (Glob.),glucose (Glu.), triglycerides (TGs), total cholesterol (Total-cholest), high-density lipoprotein cholesterol (HDL-cholest), low-density lipoprotein cholesterol (LDL-cholest), alanine aminotransferase (ALT), aspartate aminotransferase (AST), creatinine (Creat.), uric acid (U-acid) and urea were conducted by using commercial kits, Olvex Diagnosticum, Russia. Globulin was calculated as the difference between Total-P and Alb. (Kaneko *et al*., 2008).Antioxidant status was estimated by glutathione peroxidase (GSH-px), superoxide dismutase (SOD) and malondialdehyde (MDA) of serum blood, these parameters were measured by using the Agat-Med (Агат-Мед) diagnostic kits, Russia.

Statistical analysis

Statistical analysis of the obtained data from the present study was carried out through SAS software (version 9.1.3, 2003) and the data were subjected to one-way ANOVA. The results were expressed as mean ±SE. Significance of differences between means were calculated with Duncan's test (Duncan, 1955).

RESULTS

Growth performance

BW, BWG, FI and FCR of broilers that fed diets supplemented with OR-Se are presented in Table (2). Adding OR-Se (0.6 and 0.9 mg/kg diet) to chick diets significantly improved BW, BWG and FCR of these chicks throughout the last three weeks of experimental period compared to others in the control group, under high temperature conditions. Supplemental 0.9 mg/kg diet had significantly the higher level ($P< 0.05$) of BW, BWG at all periods of the experiment. However, FI did not significantly change ($P> 0.05$) between the experimental groups.

3.2. Carcass traits

Results presented in Table (3) showed that supplementation broiler diets with 0.6 and 0.9 mg OR-Se/kg statistically ($P< 0.05$) increased carcass yield % and decreased abdominal fat % but the percentages of gizzard, liver, heart and spleen were not affected by addition OR-Se.

3.3. Nutrient digestibility

Dry matter (DM), crude protein (CP), ether extract (EE) and crude fiber (CF) digestibility of birds fed diets supplemented with different levels of OR-Se are presented in Table (4). OR-Se in diets at 0.6 and/or 0.9 mg/kg markedly increased ($P< 0.05$) the nutrient digestibility of CP and EE compared to the control group. Nevertheless, no changes ($P> 0.05$) were observed in the digestibility of DM and CF.

3.4. Hematological characteristics

RBC, leukocytes, Hb and Hct levels of broilers fed diets containing different levels of OR-Se are presented in Table (5). Higher supplemental OR-Se (0.6 and 0.9 mg/kg) in the diet recorded higher ($P< 0.05$) RBC count, Hb, and Hct, compared to un-supplemented group under exposure to high temperatures. However leukocytes concentration values did not differ between supplemented groups and the control.

3.5. Biochemical blood parameters

The blood biochemical constituents of chicks received diets supplemented with OR-Se under high temperature condition are presented in Table (6). These results indicated that supplemental 0.6 and 0.9 mg OR-Se per kg diet to stressed broilers linearly (P< 0.05) increased Total-P and Glob. concentrations, whereas birds in these groups recorded the lowest (P< 0.05) levels of serum Glu.

Broilers in experimental groups (T_3 and T_4) exhibited lower (P< 0.01) serum TGs, Total-cholest, LDL-cholest, ALT, AST, Creat., and U-acid, but higher (P< 0.05) serum HDL-cholest, than those in T_2 or the control (T_1) groups. However, the level of Alb. and urea in serum did not change between the experimental groups.

3.6. Antioxidant activity

Antioxidant activities: GSH-Px, SOD and MDA of birds fed diets supplemented with OR-Se under summer conditions are presented in Figure (2). These results indicated that chicks receiving 0.6 or 0.9 mg OR-Se/kg diets remarkably improved GSH-Px and SOD, while the chicks in the other groups had significantly the lower (P< 0.05) level in MDA compared to the control group.

DISCUSSION

Growth performance

In the present study, BW, BWG and FCR had significantly improved (P< 0.05) in chicks fed diets supplemented with 0.6 or 0.9 mg OR-Se/kg, however FI did not differ in comparison with others in groups under high environmental temperature (Table 2). These results are fully agreement with Markovic *et al.*, (2018) who showed that adding different levels of OR-Se (ALKOSEL® R397) improved growth parameters except FI which did not significantly change (P> 0.05) compared to the control group. Also, Bami *et al.*, (2022) indicated that there is no significant effect on growth performance by adding lower levels (0.075, 0.15 and 0.3 mg/kg diet) of Se (green synthesized Nano Se). Dietary supplementation with Se nanoparticles (0.1 and 0.2 mg/kg) throughout the entire period (1-35 days of age) significantly improved BW and BWG but there were no effects on FI and FCR under HS conditions compared to the control (Abdel-Moniem *et al.*, 2022). On the other hand, Habibian *et al.*, (2016) reported that supplemental Se (selenomethionine) at levels 0.5, and 1 mg/kg to broiler diets did not significantly affect the performance under either a thermoneutral (24 °C constant) or HS conditions (37 °C) of these birds compared to others received diets without any addition.

According to the results of this study, the improvement of OR-Se addition on stressed broilers may be due to the positive effect of dietary Se on feed utilization and nutrient absorption (Table 4) and may be due to that Se can improve the ability of animal to adapt and manage with the stress due to its superior capacity to bound cortisol and the active thyroid hormone (T3) (Gozalez-Reves., 2020), besides Se has a positive effect in exchange Thyroxin (T4) into Triiodothyronine (T3) that is more effective in raising metabolism and the metabolic rate in the body (Choupani *et al.*, 2014).

Carcass traits

Chicks fed diets with OR-Se had better carcass yield and lower abdominal fat of stressed chicks, nevertheless these birds did not have changes in gizzard, liver, heart, and spleen percentages compared to un-supplemented chicks. Similar findings have been noted by Abdel-Moniem *et al*., (2022) who showed that, Se addition to stressed broiler markedly enhanced carcass yield and significantly reduced (P> 0.05) abdominal fat, however the percentages of gizzard, liver, heart, and spleen were not affected by Se addition. Also, Ibrahim *et al*., (2022) indicated that supplemented turkey diets with different forms of Se (organic and in organic) significantly increased carcass yield and gizzard percentages, but liver and heart percentages did not significantly differ (P> 0.05). Furthermore, chicks that reared under HS (35±1°C) from 10 am to 2 pm (4 hours) and fed diets with 1 mg OR-Se/kg diet (Sel-Plex, Alltech Inc., Nicholasville, KY) markedly enhanced carcass yield of stressed chicks (Calik *et al*., 2022). Conversely, carcass yield of broilers was not significantly affected by dietary Se supplementation (Baltic *et al.*, 2016 and Khatun *et al.* 2019). Our results suggest that, the increase in carcass yield (%) may be attributed to the improved growth performance of supplemented birds (Table 2) and the synergistic antioxidant action of Se that can alleviate of the negative effects of oxidative damage (Surai and Kochish., 2019; Shakeri *et al*., 2020). Besides, Ibrahim *et al*, 2022 noted that the enhancement in carcass yield is depend on the activity of GSH-Px (Table 7) and Hb levels in the blood (Table 5), and the deposition rate will be better, and the bioavailability of the Se improved.

Nutrient digestibility

The present study indicated that, OR-Se supplementation at 0.6 and 0.9 mg/kg diet statistically increased the nutrient digestibility of CP and EE, but there were no significant changes in DM and CF digestibility compared to the control group. These findings agree with the study of Abdel-Wareth *et al.*, (2022) who stated that adding antioxidant additives (nanoparticles of zinc oxide) to broiler diets under hot climate can improved nutrient digestibility of CP and EE and did not have effect on DM. Likewise, dietary supplemental 100 mg zinc and 0.5 mg Se enriched spirulina/kg diet for rabbits under summer conditions led to an increase CP and EE digestibility, but DM and CF digestibility did not differ compared to the control group (Hassan *et al*., 2021). In contrast, Rezvani and Shojaee (2021) indicated that adding vitamin E-selenium to the drinking water (1 ml/ L) had no effect on DM, CP and EE digestibility of broilers under HS. Furthermore, Sa’aci *et al*., 2021 revealed that there was no effect on digestibility nutrients of DM, CP, EE and CF by adding Nano Se (0.10, 0.15, 0.20 and 0.25mg/kg diet) of broilers for 21 days (from d 28 to d 49).

The increase in CP and EE digestibility in birds received diets supplemented with Se in the current experiment might be attributed to the improvement in the antioxidative status of stressed broilers (Figure 2). While, the increase in Se concentration in the blood and duodenal mucosa as well as the activities of thrioredoxin reductase and gluatathione peroxidase in duodenal mucosa (Chen *et al*., 2022).Whereas, Safiullah *et al*., (2019) indicated that the addition of Se to the broiler diets can improve the performance, immunity, and antioxidant capacity of chicks exposed to HS (37°C), this may be due to the addition of Se which can protect the small intestine and pancreatic tissue from the oxidative stress and led to high digestibility of nutrients under HS (Habibian *et al*., 2015).

Hematological characteristics

The current findings revealed that dietary OR-Se supplementation significantly increased RBC, Hb and Hct of broilers under high ambient temperatures, leukocytes was not significantly affected compared with control group chicks. **Ayyat *et al*., (2018)** conducted that under summer season, growing rabbits that received diets with OR-Se (Sel-Plex®) had higher RBC, Hb and leukocytes compared to others in the control group.

Our findings suggest that, the higher levels in RBC and Hb values could be the result of higher ($P< 0.05$) GSH-Px (Figure 2), HS occurs higher generation of reactive oxygen species and exposure of RBC as a result for high degrees of oxidative stress (Zheng *et al*., 2019). While, GSH-Px is an enzyme that has a main role in protection of RBC and Hb in RBC against free radicals and oxidative stress, consequently adding Se can prevent damage of RBC (Huang *et al*., 2012).

Biochemical blood parameters

The data of this study indicated that stressed chicks fed diets with 0.6 and 0.9 mg OR-Se/kg had significantly higher ($P< 0.05$) total-P, Glob., and HDL-cholest, while these chicks had lower Glu., TGs, total-choles, LDL-cholest, ALT, AST, Creat., and U-acid. And there were no markedly changes in Alb. and urea, compared to those in the control group. These results agree with those obtained by Hassan *et al*., (2021) who mentioned that stressed chicks fed diets with 0.5 mg Se enriched spirulina/kg diet, had higher values in total-P, Glob., and HDL-cholest. Besides, these chicks recorded the lower values in total lipids, TGs, total-cholest, LDL-cholest, however had no significant alterations in Alb., AST, and ALT compared to in the un-supplemented group. Similarly Abdel-Moniem *et al*., (2022) indicated that dietary supplementation with Se nanoparticles linearly decreased TGs, Total-cholest and LDL-cholest under HS conditions. Also, dietary supplementation with OR-Se (Sel-Plex®) for growing rabbits under summer season statistically increased total-P, Glob., AST and had no effects on urea levels in serum compared to stressed animals in the control (Ayyat *et al*., 2018).

The improvement of serum protein and lipid profile by OR-Se addition under summer conditions of this study may be due to the improvement in performance (Table 2) and digestibility of nutrients (Table 4), in addition that the main role of Se for improving antioxidant status (Table 7). Also, a decrease serum globulin and creatinine of supplemented groups (T_3 and T_4) that may be reflected the role of Se by decreasing the concentration of corticosterone, whereas under HS, corticosterone concentration increased, consequently amino acids are converted to glucose therefore occurs increasing the levels of blood Glu. that leads to gluconeogenesis (Kim *et al*., 2022).

Antioxidant activity

The outcomes of our present study indicated that the stressed chicks fed diets containing 0.6 and 0.9 mg OR-Se/kg noticeably increased GSH-Px, SOD, and decreased MDA. The current results and previous studies indicated that dietary Se supplementation can improve the overall antioxidant potential (Surai and Kochish, 2019; Woods *et al.*, 2021; Abdel-Moniem *et al.*, 2022 and Ibrahim *et al.*, 2022).Similar results to our presented data were revealed by Gul *et al*., 2021, who showed that dietary supplementation with Orgainc-Se (Se enriched yeast) improved antioxidant system, while significantly increased serum GSH-Px, SOD, and reduced ($P < 0.05$) MDA under HS conditions. Also, Abdel-Moniem *et al* (2022) reported that the supplemental dietary Nano Se in the stressed broiler diets markedly enhanced GSH-Px, SOD, and decreased MDA levels of serum stressed chicks.

The antioxidant activity of Se could be attributed to Se participation in selenoproteins synthesis, including GSH-Px system and thioredoxin system (Surai and Kochish, 2019). The same authors reported that the reduction in MDA concentration in chickens fed diets supplemented with Se, caused no oxidative stress conditions in the cell. Moreover, indicated that Se is capable to increase GSH-Px level which catalyzes the reduction of detrimental hydrogen peroxide to water or the parallel alcohols (Park *et al*., 2018 and Surai and Kochish, 2019).

CONCLUSION

It could be concluded that dietary OR-Se supplementation with 0.6 or 0.9 mg/kg diet can improve growth performance, carcass characteristics, digestibility of nutrients, blood constituents, and antioxidant capacity of broiler chicks practically under high temperature conditions.

Table (1): Ingredient composition and nutrient analysis of the control diet

Ingredient, %	**Starter (1-21 d)**	**Finisher (22-35 d)**
Yellow corn, 8.5%	48.25	53.70
Wheat, 12.5%	3.00	5.00
Soybean meal, 44%	32.38	23.49
Sunflower meal, 32%	3.00	5.00
Corn gluten meal, 60%	5.00	5.00
Sun flower oil	4.50	4.40
Dicalcium phosphate	2.00	1.30
Dl-methionine	0.12	0.12
L-Lysine	—	0.47
Limestone	1.15	0.92
Salt	0.30	0.30
Vitamin-mineral premix[a]	0.30	0.30
Analytical composition		
Dry matter (DM)	92.15	92.02
Crude protein (CP)	22.56	20.47
Crude fiber (CF)	3.84	3.65
Ether extract (EE)	6.33	7.74
Calculated composition		
Metabolizable energy (kcal per kg)	3074	3173
Calcium	1.00	0.74
Available phosphorus	0.52	0.48
Methionine+ Cystine	0.87	0.80

[a]Provided per kilogram of diet: Vitamin A, 12,500 IU; Vitamin B_{12}, 3 mg; Vitamin E, 30 IU; Vitamin K, 2.3 mg; Vitamin D_3, 4000 IU; Niacin, 65 mg; Thiamine, 2.2 mg; Riboflavin, 8 mg; Pyridoxine, 4 mg; biotin, 0.25 mg; Pantothenic acid, 24.3 mg; Choline, 600 mg; Folic acid, 1.2 mg; 125.1 mg; Iron, 60 mg; Copper, 7.5 mg; Selenium, 0.35;Manganese,100 mg; Iiodine, 1.8 mg; Zinc, 110 mg.

Table (2): Body weight, body weight gain, feed intake and feed conversion ratio of broiler chicks as affected by dietary supplementation with organic selenium (OR-Se) under summer conditions

Parameter	Treatments				SEM	p-value
	T_1 (control)	T_2	T_3	T_4		
Body weight (BW), g						
One day	43.00	43.66	41.89	41.99	0.94	0.522
3 weeks	817.39[b]	853.63[ab]	884.35[ab]	916.72[a]	27.18	0.039
5 weeks	1788.40[b]	1869.90[b]	2006.23[a]	2057.52[a]	41.22	0.006
Body weight gain (BWG), g						
1-3 weeks	774.39[b]	809.97[ab]	842.46[ab]	874.73[a]	27.55	0.039
4-5 weeks	971.01[b]	1016.28[b]	1121.87[a]	1140.80[a]	18.21	0.0004
1-5 weeks	1745.39[b]	1826.25[b]	1964.34[a]	2015.53[a]	41.71	0.006
Feed intake (FI), g						
1-3 weeks	1012.17	1081.00	1107.34	1140.43	33.54	0.122
4-5 weeks	1846.39	1907.02	1946.04	1943.05	29.33	0.134
1-5 weeks	2858.56	2988.01	3053.38	3083.48	59.49	0.107
Feed conversion ratio, (FCR)						
1-3 weeks	1.31	1.33	1.31	1.30	0.01	0.233
4-5 weeks	1.90[a]	1.88[a]	1.74[b]	1.70[b]	0.026	0.001
1-5 weeks	1.64[a]	1.64[a]	1.56[b]	1.53[b]	0.013	0.001

[a,b]– means with different letters in the same row are significantly different at (P< 0.05).SEM, standard error of the mean.

Table (3): Carcass traits of broiler chicks as affected by dietary supplementation with organic selenium (OR-Se) under summer conditions

Parameter	Treatments				SEM	p-value
	T_1 (control)	T_2	T_3	T_4		
*LBW, g	1833.55[b]	1891.47[b]	2017.70[a]	2037.19[a]	36.680	0.012
Carcass yield, %	70.85[b]	70.84[b]	74.55[a]	73.97[a]	0.861	0.026
Gizzard, %	1.74	1.77	1.90	1.84	0.074	0.471
Liver, %	2.12	2.18	2.32	2.37	0.106	0.378
Heart, %	0.42	0.41	0.46	0.45	0.021	0.338
Abdominal fat, %	1.64[a]	1.58[a]	1.36[b]	1.34[b]	0.062	0.020
Spleen, %	0.147	0.137	0.127	0.127	0.011	0.544

[a,b] – means with different letters in the same row are significantly different at (P< 0.05).SEM,standard error of the mean. * LBW, live body weight.

Table (4): Nutrient digestibility of broiler chicks as affected by dietary supplementation with organic selenium (OR-Se) under summer conditions

Parameter	Treatments				SEM	p-value
	T_1 (control)	T_2	T_3	T_4		
Dry matter, DM	71.42	71.49	71.85	72.16	0.38	0.520
Crude protein, CP	64.48^b	66.05^b	69.95^a	72.35^a	0.93	0.001
Ether extract, EE	67.61^b	67.43^b	70.37^a	70.40^a	0.52	0.005
Crude fiber, CF	30.02	29.17	29.79	30.42	0.57	0.513

^{a,b} – means with different letters in the same row are significantly different at (P< 0.05).SEM, standard error of the mean.

Table (5): Hematological parameters of broiler chicks as affected by dietary supplementation with organic selenium (OR-Se) under summer conditions

Parameter	Treatments				SEM	p-value
	T_1 (control)	T_2	T_3	T_4		
Red blood cells (RBC), 10^6/mm3	1.97^b	2.08^b	2.41^a	2.44^a	0.085	0.010
Leukocytes, 10^4/mm3	2.28	2.62	2.57	2.56	0.174	0.544
Haematocrit (Hct),%	29.46^b	29.83^b	32.83^a	33.38^a	0.393	0.0002
Hemoglobin (Hb), g/dl	6.97^b	6.98^b	8.33^a	8.26^a	0.253	0.006

^{a,b}– means with different letters in the same row are significantly different at (P< 0.05).SEM, standard error of the mean.

Table (6): Biochemical blood parameters of broiler chicks as affected by dietary supplementation with organic selenium (OR-Se) under summer conditions

Parameter	Treatments				SEM	p-value
	T_1 (control)	T_2	T_3	T_4		
[1] Total-P, g/dl	3.52^b	3.61^b	4.02^a	4.05^a	0.117	0.026
[2]Alb., g/dl	1.62	1.68	1.77	1.91	0.110	0.333
[3]Glob., g/dl	1.90^b	1.93^b	2.25^a	2.14^{ab}	0.078	0.038
[4]Glu., mg/dl	216.23^a	197.45^a	148.82^b	155.05^b	7.75	0.001
[5]TGs, mg/dl	150.64^a	143.10^a	120.42^b	116.94^b	3.84	0.001
[6]T-cholest, mg/dl	174.26^a	152.22^b	130.90^c	127.22^c	5.65	0.001
[7]HDL-cholest, mg/dl	34.69^b	34.06^b	43.60^a	42.88^a	1.93	0.012
[8]LDL-cholest, mg/dl	79.90^a	79.58^a	62.58^b	61.82^b	1.82	<.0001
[9]Creat., mg/dl	0.88^a	0.88^a	0.65^b	0.62^b	0.04	0.003
[10]U-acid, mg/dl	5.03^a	4.47^{ab}	3.89^{bc}	3.81^c	0.19	0.007
Urea, mg/dl	15.52	15.20	14.60	14.58	0.24	0.056
[11]ALT, U/L	7.32^a	7.57^a	6.48^b	6.84^{ab}	0.24	0.047
[12]AST, U/L	206.70^a	205.72^a	183.46^b	182.61^b	4.89	0.010

[a,b,c] – means with different letters in the same row are significantly different at ($P< 0.05$).SEM, standard error of the mean. [1]Total protein, [2]Albumin, [3]Globulin, [4]glucose, [5]Triglycerides, [6]Total cholesterol, [7]High-density lipoprotein cholesterol, [8]low-density lipoprotein cholesterol, [9]Creatinine, [10]Uric acid, [11]Alanine aminotransferase, [12]Aspartate aminotransferase.

Figure (1): Ambient temperature (C°) and relative humidity (%) during the period of experiment (1-35 days of age)

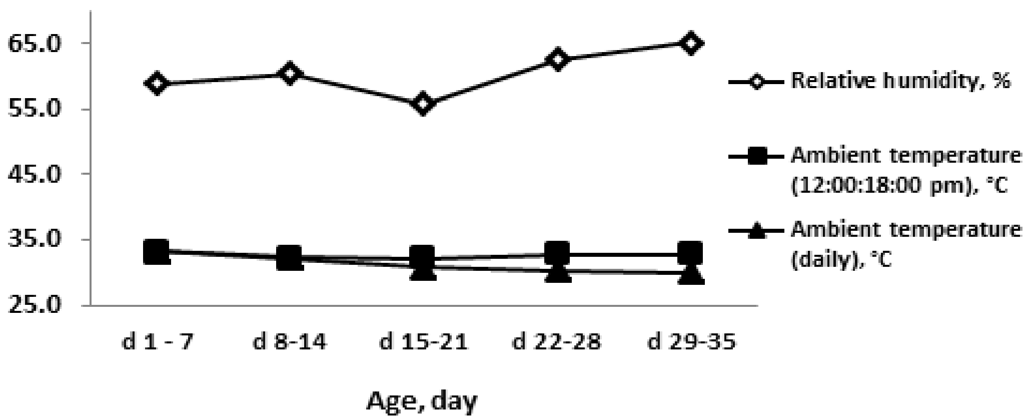
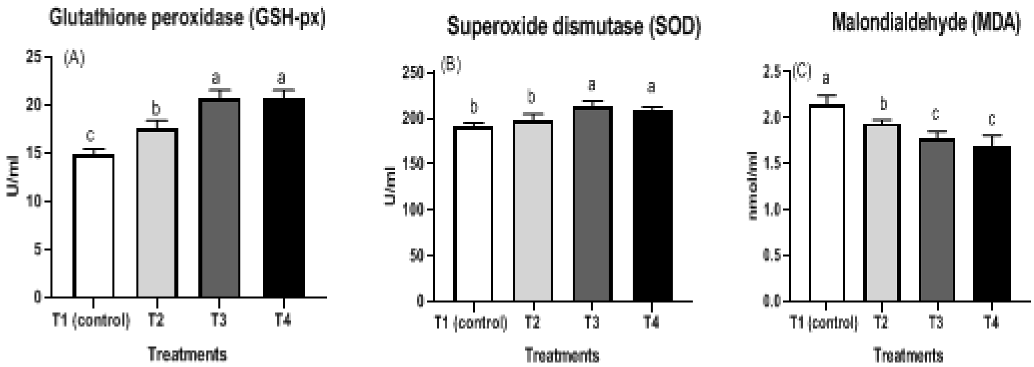


Figure (2): (A, B, and C). Serum antioxidant activity of broiler chicks fed either a control diet (T_1), the control diet plus 0.3 mg OR-Se (T_2), the control diet plus 0.6 mg OR-Se (T_3), the control diet plus 0.9 mg OR-Se (T_4)/kg diet under summer conditions. a,b and c – letters with different superscripts differ statistically at (P< 0.05)



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broiler, stress, selenium, growth, antioxidant

الملخص العربى

تأثير إضافة السيلينيوم العضوى على الآداء الإنتاجى لبدارى التسمين تحت ظروف فصل الصيف

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أجريت هذه التجربة لتقييم إضافة السيلينيوم العضوى على آداء النمو، صفات الذبيحة، معاملات الهضم لبعض العناصر الغذائية، المواد التمثيلية بالدم ومضادات الأكسدة لعلائق بدارى التسمين. إستخدم 320 كتكوت غير مجنس عمر يوم (سلالة Cobb-500) خلال موسم الصيف تحت درجة حرارة تراوحت بين 29.9 و 33.3 درجة مئوية. قسمت الكتاكيت عشوائيا إلى أربع مجموعات كل مجموعة تضم 80 كتكوت وكانت موزعة على أربع مكررات، تحتوي كل مكررة علي20 كتكوت وتم تربيتها تربية أرضية. المجموعة الأولى تغذت على عليقة كنترول، أما المجموعات الثانية، الثالثة والرابعة تغذت على عليقة كنترول مضاف اليها 0.3، 0.6 و 0.9 ملليجرام سيلينيوم عضوى لكل كجم عليقة على الترتيب. أوضحت النتائج المتحصل عليها أن المجموعات المضاف لها سيلينيوم (المجموعات الثالثة والرابعة) أدي إلى تحسن معنوي في مؤشرات النمو(وزن الجسم ،الزيادة فى وزن الجسم، معدل التحويل الغذائى) وتحسن في معاملات الهضم .هذه المجموعات سجلت أيضا مستوي عالي (P< 0.05) في وزن الذبيحة ومستوي منخفض (P< 0.05) في دهن البطن. بالإضافة إلي ذلك حدث تحسن معنوي في مقاييس الدم (كرات الدم الحمراء، الهيموجلوبين و الهيماتوكريت) للكتاكيت التي تغذت علي علائق تحتوي علي سيلينيوم عضوي. وكذلك أن إضافة السيلينيوم العضوي أدي إلي تحسن في مستوي الليبيدات وانزيمات الكبد، ووظائف الكلى ومضادات الأكسدة. نستخلص من النتائج أن إضافة السيلينيوم العضوى بمستوي 0.6 و 0.9 مجم / كجم عليقة إلى علائق كتاكيت التسمين يؤدى إلى تحسين الكفاءة الانتاجية لهذه الكتاكيت عن طريق تحسن مستوي النمو، معاملات الهضم للعناصرالغذائية ، مقاييس الدم و مضادات الأكسدة تحت ظروف الصيف الحارة بالمقارنه بالمجموعة الكنترول.