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EFFECT OF DIETARY SOURCE OF SELENIUM ON PRODUCTIVE AND REPRODUCTIVE PERFORMANCE OF SINAI LAYING HENS UNDER HEAT STRESS CONDITIONS

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ABSTRACT: The main objective of this study was to investigate the effects of different ambient temperatures {thermo-neutral (TN) or heat stress (HS) in 22 and 30 wks of age} and dietary supplementation of different selenium (Se) sources {inorganic (control group) at 0.1 mg/ kg diet, organic Se (Selenium Yeast) and Nano Se each at 0.3 mg/ kg diet} on sexual maturity, laying performance, egg quality, hatchability traits and physical semen quality, as well as some blood parameters and plasma constituents for Sinai hens during the early laying stage (22-34 wks). A total of 198 (180 females + 18 males) 22-wks-old of Sinai birds were used and randomly distributed into two experimental groups (TN & HS), and then each group was divided into three sub-groups (inorganic, organic and Nano Se) in a factorial design (2x3). At 17 to 20 wks of age, birds were fed pre-lay diet contained 2% Ca then, convert to layer diet until the end of experimental period (34 wks).

The results indicated that heat stress resulted in a significant decrease in 1st egg weight and age at sexual maturity, body weight and change in body weight, laying rate (%), egg number, egg weight, egg mass and feed intake per hen, live sperms (%) and hatchability (%). External and internal egg quality and fertility (%) were not significantly affected by heat stress. Also, heat stress significantly increased total embryonic mortality, dead and abnormal sperms in semen. Besides, lymphocytes (L) cells (%), plasma total protein, hemoglobin (Hb) concentration, white blood cells count, eosinophils cells (%), monocytes cells (%), globulin, albumin, calcium, phosphorus and TAOC were significantly decreased for hens reared under heat stress. Moreover, significant increases were recorded for total lipids, heat shock protein 70 for Sinai hens reared under heat stress than those reared under thermo- neutral during the studied laying period. Supplementing different selenium sources to the diet, especially Nano selenium had significantly improved all parameters under experimental conditions as compared with control diet. These results indicated that heat stress severely reduced productive and reproductive performance for Sinai hens, whereas the productive and reproductive performance was improved by dietary different Se sources (Nano and organic Se) supplementation at 0.3 mg/ kg under heat stress conditions, without any adverse effect on the vitality of hens.

KeyWords: Heat Stress-Organic and Nano Selenium-Maturity-Laying Performance-Semen quality

INTRODUCTION

Homeostasis is constantly challenged by intrinsic and extrinsic stressors (Lin et al., 2006). Heat stress is of the major concern for poultry industry, especially in the hot regions. The important traits governing productivity (growth performance, immune suppression, egg production and high mortality rate, etc.) are adversely affected by heat stress (Mujahid et al., 2005, 2007 and Niu et al., 2009). When the temperature exceeds 30ºC, signs of heat stress are likely to appear (Yardibi and Turkay, 2008). Biochemical and physiological events associated with hyperthermia can potentially promote reactive oxygen species formation which results in the disturbance of balance between the oxidation and anti-oxidants defense systems, causing lipid peroxidation (LPO), in cell membranes, free radical peroxidation and oxidative injury in biological molecules, DNA and proteins (Ando et al., 1997; Line et al., 2006; Mujahid et al., 2008; and Aslam et al., 2010). Furthermore, heat stress increases mineral and vitamin mobilization from tissues and their excretion, thus may exacerbate a marginal vitamin and mineral deficiency or an increased mineral and vitamin requirements. Several methods are available to alleviate the negative effects of heat stress, mostly focused on dietary manipulation. The major effects of heat stress represented in decreasing feed intake and lowing weight gain (El Moniary, 1991; Cahaner and Leenstra, 1992; El -Moniary et al., 1993; and Geraert et al., 1996). High temperature is enough to cause increased body temperature also change circulating leucocyte component in broilers and increased in H/L ratio (Altan et al., 2000). Heat stress not only adversely affects production performance but also inhibits immune function (Mashaly et al., 2004). As living organisms, chickens have protective measures against environmental challenges. The heat shock proteins (HSP) are a set of proteins synthesized in response to physical, chemical, or biological stresses, including heat exposure (Ming et al., 2010). Heat shock proteins are a group of evolutionarily conserved proteins that are, conventionally, classified according to molecular size, ranging from 10 to 150 kDa462 (Benjamin and McMillan, 1998). They play an important role in the protection and repair of cells and tissues. When birds exposed to stress, selenium is used in an antioxidant enzymes to decrease the harmful effects of free radicals. One of the most conserved and important protein families and has been studied extensively is HSP70 (Ming et al., 2010).

In this regard, the source of selenium is important to provide enough protection. There are three forms of selenium as inorganic, organic and Nano selenium (Nano-Se). Recently, the latter has attracted widespread attention because of low toxicity (Wang et al., 2007; and Zhang et al., 2012). With the recent development of nanotechnology, Nano-selenium (Nano-Se) has attracted widespread attention because nanometer particulates exhibit novel characteristics such as a large surface area, high surface activity, high catalytic efficiency, strong adsorbing ability, and low toxicity (Zhang et al., 2008). Cai et al. (2012) suggested that dietary Nano-Se enhanced the antioxidant ability and oxidative stability and the optimum level of Nano-Se supplementation was ranged from 0.3 to 0.5 ppm and the maximum supplementation could not be more than 1.0 ppm in broilers. The organic selenium (OSe) in selenium yeast is readily available and is actively absorbed from the intestine via the Na+ dependent neutral amino acid pathway (Schrauzer, 2000). Upton et al. (2008) suggest that selenium from selenium yeast was used more efficiently for performance in fast growing, high yielding broiler chickens. Therefore, the main objective of this study was to investigate the effect of dietary supplementation of different selenium sources on productive and reproductive performance for Sinai hens under heat stress during the early laying stage.

MATERIALS AND METHODS

The present study was carried out at El-Serw Poultry Research Station, Animal Production Research Institute, Agricultural Research Center, Egypt. A factorial design (2x3) was used, it performed including two temperatures {thermo-neutral (TN) and heat stress (HS) conditions} and three sources of selenium {inorganic (control group) at 0.1 mg/ kg diet, organic (Selenium Yeast) or Nano selenium (Nano-Se) at an average of 0.3 mg/ kg diet}. A total number of 198 of Sinai birds (180 females + 18 males of Sinai chickens from the previous experimental treatments exposed to same treatments from 4 wks of age) 17 wks-old were randomly distributed into two experimental groups to study temperature effect, and then each group was divided into three sub-groups to study the effect of Se source. Each sub-group was divided into three replicates, each of 11 chicks. Feed and water were available ad-libitum throughout the study. Chickens were fed a pre-lay diet from 17 to 20 wks of age and layer diet from 21 wks to the end of experimental period (Table 1). A heat exposure treatment was applied at 22 and 30 wks of age, where birds were exposed to 39 ± 1ºC for 4 hours/day for 4 consecutive days from 10.00 A.M. to 14.00 P.M. using gas heaters. The temperature of the control treatment was the normal ambient temperature (from 23 to 24ºC). Electric fans were used to maintain the indoor temperature within this range and the relative humidity was 55-60 %, with the use of selenium as an anti-stress factors.

Nano selenium preparation:

The prepared SeNPs, sodium selenite pentahydrate $Na_2SeO_3 \cdot 5H_2O$ was dissolved in bi-distilled water, and 3-mercaptopropionic acid was then slowly added to the solution under stirring. Afterwards, pH was adjusted to eight using 1 M NaOH. The mixture was stirred for 2 h. SeNPs were stored in darkness at 4°C. One millilitre of the solution contains 158 µg of Se nanoparticles (50–100 nm in diameter). Chemicals used in this study were purchased from Sigma-Aldrich in ACS purity unless noted otherwise (Chudobova et al., 2014).

Data collection and estimated parameters:

Laying performance traits: Body weights of hens were recorded during the experimental period (22 – 34 wks of age). Egg number and mass and feed consumption were recorded then were averaged and expressed per hen/ 4 wks through the periods 22-26, 26-30, 30-34, and the overall experimental period (22-34 wks of age). Laying rate and feed conversion ratio were calculated through the same periods as well as the body weight change which was calculated through the whole experimental period.

Egg quality parameters: At 34 wks of age, a total number of 90 eggs (15 from each treatment) were randomly taken to determine some egg quality parameters including shape index, yolk index, yolk, albumen and shell weights as a percentage of egg weight, shell thickness (mm) and Haugh units.

In addition, the reproduction traits: For evaluating fertility and hatchability, three hatches along with different ages were made in each experiment. The hatching eggs were collected for 7 days for incubation in each. The incubated eggs were candled at the 7th day of incubation. The number of fertile and infertile eggs and the eggs with dead embryo were recorded. Fertility (%) was calculated as a percentage of number of fertile eggs to the number of total set eggs. Hatchability (%) was calculated as a percentage of the number of healthy chicks to number of total set or fertile eggs, whereas, dead embryos (%) were calculated as a percentage of number of dead embryos to number of fertile eggs.

Rectal temperature (RT) and respiratory rate (RR): RT of birds was taken with a digital thermometer by rectal probe (0.1% accuracy) as previously described and RR of the birds was taken as the number of breaths per minute. The RT and RR were measured at 24 and 34 weeks of age.

Hematological parameters: Blood samples were obtained from the brachial vein by simple venipuncture of three birds per sub-group immediately prior to loading into the crate and upon removal. Total erythrocytic count (RBC) was performed and Hemoglobin (Hb) concentration was measured colorimetrically, using a diagnostic kit according to the manufacturer instructions. Blood smears were made for subsequent differential leukocyte analysis and haemoglobin concentration (g/dl) following May-Grunwald staining (Robertson and Maxwell, 1990) and H/L ratios were calculated (Mitchell et al., 1992).

Blood plasma constituents: Blood samples were taken from the brachial vein, plasma separated by centrifugation at 2000 g, for 20 minutes at room temperature and then labeled and stored in a deep freezer (-20°C) until analysis. Blood plasma albumin, total protein, cholesterol, TAOC, calcium, phosphorus, total lipids, triglycerides and LDL were colorimetrically determined using available commercial kits.

Concentration of Heat shock protein 70 level (HSP 70) was determined after exposure to heat challenge by ELISA method using kits of Uscn Life Science Inc. Wuhan, Chain. Specificity of this assay has high sensitivity and excellent specificity for detection of gallinaceous HSP70. No significant cross-reactivity or interference was observed.

Semen collection and determination of semen physical traits: The cocks used in this study were selected on the basis of a positive reaction to dorso-abdominal massage (Kammer et al., 1972) for artificial collection of semen. Semen was collected weekly during the experimental period, within 20 min after collection, ejaculate volume, motility (mass and advanced) and spermatozoa concentration were determined for each cock. Semen smears were done to study the morphology of spermatozoa after nigrosin-eosin staining of smears (Bakst and Cecil, 1997) for counting dead spermatozoa and total abnormalities percentages.

Statistical analysis: The data obtained herein were analyzed by General Linear Model procedures (GLM) described in SAS User’s Guide (SAS Institute, 2003). The mathematical model used in this study was:

$Y_{ijk} = \mu + T_i + R_j + (TR)_{ij} + e_{ij}$ where:

Yijk = an observation;

μ = Overall mean; T = Effect of ambient temperature; i= (1 and 2);

R = Effect of dietary selenium source; j = (1, 2 and 3);

TR=Effect of interaction between the ambient temperature and dietary selenium source;

e_{ij} = Experimental random error

Differences among treatment means were separated by Duncan’s new Multiple-Range test (Duncan, 1955).

RESULTS AND DISCUSSION

Sexual maturity (SM) and body weight change (BWC):

The subsequent effect for previous experimental treatments during the growth period on SM and IBW are presented in Table (2). Results show that there is a significant effect of ambient temperature on sexual maturity. Means presented showed that heat stress (HS) reached to SM at earlier age (124 day) and lowest egg weight (30.44 g) was found than thermo-neutral (TN) (127 day and 34 g), respectively. As regarded of selenium sources, the birds received Nano selenium reached to SM at earlier age (123.5 day) than the control group (130 day) followed by the birds fed diet supplemented with organic selenium (125.17 day). This result is in line with the findings of Waseem et al. (2016) who reported that the selenium yeast (SY) containing diet of pullets exhibited earlier sexual maturity compared to those of the no Se or Sod-Se supplemented groups (Surai, 2006). On the other hand, the 1st egg weight (g) significantly increased for groups fed diet of Nano and organic Se (32.83 and 31.67 g) than those of the control (29.17 g). Interaction between ambient temperature and selenium sources had no significant effect on age of SM, whereas a significant effect on the 1st egg weight was detected. The highest 1st egg weight was recorded with TN and Nano Se treatment.

Results of Table (2) shows the IBW and FBW were significantly affected due to ambient temperature. Heat stress lead to a significant decrease in IBW and BWC for Sinai hens compared with those reared in thermo-neutral. FBW was significantly lower by 5.9% for hens exposed to high temperature than those reared in thermo-neutral during the experimental period.

This result may be due to heat stress which decreased feed consumption, absorption, assimilation and utilization of nutrient (Withers, 1992). Also, it decreased growth speed and heated shock proteins description which kept the other proteins against destruction. These proteins were replaced by other cell synthesis proteins and decreased structural proteins production (Edens et al., 2000). Moreover, body weight gain was impaired as a result of the change of respiratory alkalize pattern (Line et al., 2006). On the other hand, different sources of selenium had a significant effect on body weight change of hens during overall experimental period, where the body weight change was significantly increased with Nano and organic Se as compared with the control. These results are in agreement with Upton et al. (2008) who reported significant increases in the body weight for broilers at 42-d of age by dietary organic Se supplementation at 0.2 mg/ kg diet as compared with diet supplemented with inorganic selenium and a control diet (no supplemented Se). Dlouhá et al. (2008) observed that feeding a diet contained 0.30 mg Nano-Se/ kg produced the greatest improvement in chicken's weight. Also, Zhou and Wang (2011) found that final body weight was significantly ($p<0.05$) improved by feeding diet supplemented with 0.10, 0.30, and 0.50 mg Nano-Se /kg as compared to the control after 90 days of feeding. However, the interaction between ambient temperature and different sources of selenium had no significant effect on body weight change in Table (2).

Laying hens performance:

Results in Table (3) clearly shows that the subsequent effect of the experimental different sources of selenium during growing period significantly exceeded as compared to control diet with respect to egg number/ hen and laying rate % during the period from 22-34 weeks of age. Results from this table declared that, heat stress had a significant decrease in egg number/ hen and laying rate % as compared to thermo-neutral during all experimental periods. Egg number was significantly decreased by 2.4% while laying rate decreased by 0.91% during overall experimental period (22-34 wks of age). Dietary supplementation of varying selenium sources (organic and Nano selenium) resulted in a significant increase in egg number/ hen and laying rate %. The greatest egg number was produced by the birds fed diet of Nano selenium comparing with the other groups following by the diet of organic selenium. Seemingly, laying rate % was significantly improved by diet of Nano-Se comparing with other treatments during overall experimental period.

These results are in agreement with Nadia et al. (2015) who reported that Nano-Se supplementation in layer diets significantly increased egg production percentage and egg mass and improved feed conversion ratio compared with sodium selenite The improvement for productive performance may be attributed to Se supplementation, where Se is an important auxiliary factor for the key enzyme of 5-deiodinase. The iodothyronine deiodinase enzymes convert the pro-hormone thyroxine (T 4) to the active form triiodothyronine (T3). Triiodothyronine is a main hormone that regulates growth by controlling the body's energy and protein anabolism (Arthur et aI., 1999; Preter, 2000). Selenium is an integral part of GSH-Px, which eliminates some of free radicals from metabolic activity. The increase in free radicals has been correlated with reductions in productive performance (Underwood and Suttle, 1999). On the other hand the interaction between ambient temperatures and dietary selenium sources had no significant effect on egg number and laying rate at different ages except for that of egg number and laying rate during period of (22-26) wks which was significantly affected (Table 3).

Results of Table (4) shows that the egg weight (g) and egg mass (g/ hen) were significantly affected due to ambient temperature. Heat stress lead to a significant decrease in egg weight and egg mass for Sinai hens compared with those reared in thermo-neutral. The average egg weight was smaller by 1.42% with heat stress than that of the thermo-neutral during overall experimental period. Also, egg mass values, closely related to the egg number where the birds fed diet of heat stress produced a significant decrease in egg mass by 3.82% compared with those fed diet of thermo-neutral. As shown in Table (4), egg weight (g) and egg mass g/ hen during overall experimental period during period of (22-34 wks) significantly improved with Nano selenium as compared with other treatments. The egg weight and egg mass were increased by (5.13 and 2.09%) and (15.55 and 8.00%) with Nano and organic selenium respectively, as compared with thermo-neutral. These results are in agreement with Gjorgovska et al. (2012) and Attia et al. (2010) indicated that egg weight and egg mass significantly increased and feed conversion ratio was improved by Se supplementation compared with hens fed the control diet. Nevertheless, the interaction between ambient temperatures and dietary selenium sources had no significant effect on egg weight and egg mass at different ages except those of egg number, laying rate and egg mass/ hen at (22-26 wks) which were significantly affected (Table 4).

Results in Table (5) shows that feed consumption (g/ hen) was significantly affected due to ambient temperature. It could be noticed that birds with heat stress had significantly consumed lower amount of feed than those of the control during all experimental periods except during period of (22-26 wks) of age which did not significantly affected. Feed consumption of hens with heat stress was significantly decreased by about 2.18 % lower than birds with thermo-neutral during overall experimental period. These results may be due to that heat which stress decreased feed intake in order to reduce metabolic heat production (Pelicano et al., 2005). Ribeiro et al. (2008) observed that feed intake was lower by 5.5% for Ross broilers reared under heat stress than birds housed under thermo-neutral environment. FC was significantly affected due to selenium sources supplementation to hen diet during all studied periods (Table 5). Data of FC significantly recorded the lowest amount for hens fed diet supplemented with all studied selenium sources compared to those fed the control diet during overall experimental period. The decrease in FC was 5.61 and 4.34% for hens fed diet of Nano, organic selenium as compared to control diet (without selenium) during the overall experimental period, respectively. These results are in agreement with the findings of Zhou and Wang (2011) who found that feed conversion ratios were ($p<0.05$) improved for the groups fed diet supplemented with 0.10, 0.30, and 0.50 mg Nano-Se/ kg as compared with those fed the control diet after 90 days of treatment. Interaction between ambient temperatures and dietary selenium sources had no significant effect on FC.

Feed conversion ratio (FCR) (g feed/ g EM) was significantly affected by ambient temperatures during all the experimental periods except periods of (26-30) and (30-34) wks of age (Table 5). While FCR was significantly improved by different sources of selenium in Sinai hens diets compared with control diet. Interaction between ambient temperatures and dietary selenium sources had no significant effect on Feed conversion except that of (22-26) wks which was significantly affected (Table 5).

External and internal egg quality:

Results of Table (6) shows the effect of ambient temperature and different selenium sources during laying hens on external egg quality (shell weight %, shell thickness and egg shape index) and internal egg quality (albumen weight %, yolk weight %, yolk index and Hough unit). External and internal egg quality were not significantly affected due to ambient temperature and selenium sources supplementation to laying hens during experimental period except those of egg shape index, yolk weight % and Hough unit which were significantly different according to selenium sources. These results are in agreement with findings of Attia et al. (2010) who found that supplementation of inorganic or organic selenium in the diets, had no significant effect on any traits of egg quality, showing that Se content of the basal diet was adequate to support egg production of good quality. Also, Gajcevic et al. (2009) indicated that eggs produced by hens fed a diet supplemented with organic selenium had higher Haugh unit values than eggs of hens fed the control diet. Interaction between ambient temperatures and dietary selenium sources had no significant effect on egg quality (external and internal**).**

Rectal temperature and respiratory rate:

Results in Table (7**)** shows that rectal temperature and respiratory rate were significantly ($p<0.05$ and 0.01) higher for Sinai hens reared under heat stress than for those reared in thermo-neutral at 24 and 34 weeks of age. Similar results were reported by Altan et al. (2000) who found that broilers respond to high temperature had higher respiratory rate and body temperature. Silva et al. (2001) demonstrated that the physiologic responses include respiratory frequency and body temperature were increased when the chickens are exposed to hot environmental conditions Also, Borges et al. (2004) reported that the duration of the high temperature stress significantly increased the body temperature and respiratory frequency. Moreover, dietary supplementation of different Se sources had no significant effect on rectal temperature but dietary selenium source had significant effect on respiratory rate at different ages (Table 7). Interaction between ambient temperatures and dietary selenium source had no significant effect on rectal temperature but respiratory rate at different ages was significantly affected by the interaction (Table 7).

Blood hematology and plasma constituents:

Results in Table (8) shows that heat stress resulted in a significant ($P\leq0.01$) decrease in RBC count, Hb concentration, WBC count, heterophils (H) cells (%), lymphocyte cells (%) and H / L ratio for Sinai chicks as compared with those reared in thermo-neutral at the end of experimental period. This finding is in agreement with those obtained by Ajakaiye et al. (2010) who showed the presence of a decrease ($p\leq0.05$) in total white blood cell, ($p\leq0.01$) lymphocyte and monocyte values, and a significant ($p\leq0.05$ and 0.01) increase in the values of eosinophils and heterophils post-transportation, respectively. On the other hand, supplementing different sources of Se (Organic or Nano selenium) to the diet resulted in a significant increase in RBC count, Hb concentration, WBC, H (%) and H/L ratio and a significant decrease in L (%) for Sinai hens than for those with control diet (no supplemented selenium) at the end of experimental period. These results may be due to that selenium leads to improve in the activity of hemopoietic organs in order to increase RBC count, hemoglobin content and packed cell volume (Ihsan and Qader, 2012). Also, it may be due to that organic and Nano-Se improves the immunomodulating properties and increased cellular immunity (Surai, 2006; Mohapatra et al., 2014). These results are in agreement with those obtained by Selim et al. (2015) who found that hematological examination showed significantly highest RBC count, PCV and hemoglobin values by adding organic or Nano forms of Se compared to inorganic selenium. Hanafy et al. (2009) and EI-Sheikh et al. (2010) reported that organic selenium supplementation at 0.2 and 0.3 ppm significantly increased the concentrations of hemoglobin concentration. Mohapatra et al. (2014) reported that Nano-Se appeared to be more effective ($P<0.05$) in increasing different hematological parameters than that of inorganic sodium selenite at level of 0.3 ppm. Selenium has an antioxidant effect on the red blood cell membrane; it prevents the degradation of the mature erythrocytes. Because of the intensification of the erythropoiesis, the red blood cell count and the hemoglobin value increase (Raduta et al., 2011). In contrast, Selim et al. (2015) showed that Lymphocytes significantly increased, while heterophilous and H/L ratio significantly decreased by organic selenium treatments. In this connection, Ihsan and Qader (2012) and Shlig (2009) stated that there were significant differences ($p<0.05$) on lymphocytes, heterophilus percentages and H/L ratio between selenium treatment groups. Nano selenium supplementation significantly increased lymphocytes while heterophilus and H/L ratio significantly decreased (Fuxiang et al., 2008).

Results in Table (9) shows that the heat stress resulted in a significant ($p<0.05$) decrease in the levels of plasma total protein, A/G ratio and albumin. These results are in agreement with those obtained by Seliem (2011) who found a significant decrease in plasma total protein, albumin in the heat stressed group, These results may be related to elevation of corticosterone which has elicited gluconeogenesis (Malheiros et al. 2003). While, globulin was not significantly affected by heat stress at 24 wks of age compared with those reared in thermo-neutral temperature, the same trend was observed at 34 wks of age, except globulin and heat shock protein 70 which were significantly higher for heat stressed hens compared with those reared in thermo-neutral temperature. From another view, dietary supplementation of varying selenium sources (Organic or Nano selenium**)** resulted in a significant ($p\leq0.05$ or 0.01) increase in plasma total protein and albumin at 24 wks of age, and plasma total protein albumin, globulin and plasma total protein and albumin at 34 wks of age (Table 9). Moreover, globulin and A/G ratio at 24 wks and A/G ratio at 34 wks of age were not significantly affected by selenium source. Total protein, globulin, albumin and A/G ratio were not significantly ($p\leq0.05$ or $p\leq0.01$) influenced by interaction between ambient temperatures and dietary selenium source at 24 and 34 wks of age. Whereas, heat shock protein 70 of Sinai chicks was significantly affected by the interaction at the end of experimental period (34 wks of age)**.**

Table (10 and 11) illustrated the effect of ambient temperatures, dietary selenium source and their interaction on some blood plasma metabolites of local Sinai hens during the early of laying stage (at 24 and 34 weeks of age). Results show that T.

Lipids, Triglycerides, T. cholesterol and LDL were significantly ($p \leq 0.001$) increased for Sinai hens reared under heat stress than for those reared in thermo-neutral at 24 and 34 weeks of age. While, HDL and H/L % were not significantly decreased by heat stress at the same two ages compared with those reared in thermo-neutral temperatures. On the other hand, different sources of selenium had significantly effect on T. Lipids, Triglycerides, T. cholesterol, LDL, HDL and H/L% of laying hens during the at 24 and 34 weeks of age (Table 10 and 11). The lowest values of T. Lipids, Triglycerides, T. cholesterol and LDL were recorded by Nano selenium followed by organic selenium as compared with the control group, while, dietary selenium whatever (Nano or organic) causes a significant ($p \leq 0.05$ or 0.01) increase in HDL and H/L ratio at 24 and 34 weeks of age as compared with a control diet (without selenium). Interaction between ambient temperatures and dietary selenium source had no significant effect on H/L% but T. Lipids ,Triglycerides, T. cholesterol, LDL and HDL at 24 wks of age were significantly affected (Table 10). Data in Table (11) shows that interaction between ambient temperatures and dietary selenium source had no significant effects on T. lipids and H/L% but Triglycerides, T. cholesterol, LDL and HDL at 34 wks of age were significantly affected.

Results in Table (12) shows that the heat stress resulted in a significant ($p<0.05$) decrease in calcium, phosphorus and total antioxidant capacity (TAOC) for Sinai hens reared under heat stress than those reared in thermo-neutral at 24 and 34 weeks of age. On the other hand, dietary supplementation of varying selenium sources (Organic or Nano selenium) resulted in a significant ($p \leq 0.05$ or 0.01) increase in calcium, phosphorus and total antioxidant capacity (TAOC) at 24 and 34 wks of age (Table 12). Dietary Nano-Se supplementation resulted in significantly higher calcium, phosphorus and TAOC by 12.86, 11.60 and 17.28%, respectively at 24 wk of age, and reached to 12.20, 9.02 and 12.13%, respectively at 34 wk of age. These results are in agreement with those reported by Wang and Xu (2008) who detected an increase of GSH-Px activity and TAOC in plasma of broilers fed on diet supplemented with Nano-Se at levels between 0.15 and 1.2 mg/kg diet, while MDA values were not affected. Huang et al. (2003) explained this trend when reported that Nano-Se has a size dependent effect in scavenging various free radicals; as small-size Nano-Se has greater ability to transfer electrons to radicals. Interaction between ambient temperatures and dietary selenium source had a significant effect on calcium, phosphorus and total antioxidant capacity (TAOC) at 24 of age , but at 34 of age, interaction had no a significant effect on phosphorus and TAOC, while interaction between ambient temperatures and dietary selenium source had a significant effect on calcium (Table 12).

Some physical semen parameters:

Table (13) shows the effect of ambient temperatures, dietary selenium source and their interaction on some physical semen parameters of local Sinai cocks during the experimental periods.

As shown, heat stress resulted in a significant decrease in Ejaculate volume, Sperm concentration, Sperm forward motility (%) and live sperms (%), while dead sperms and abnormal sperms were significantly higher than those reared under thermo-neutral. Physical semen quality was significantly improved due to selenium sources supplementation to cocks diets during experimental period (Table 13). These results are keeping with those reported by Edens (2002) who found that dietary cocks with organic Se can improve semen quality by decreasing the abnormalities of spermatozoa mid-pice damage. Also, Hanafy et al. (2009) reported that Org-Se can improve sperm motility percentage.

Ejaculate volume, sperm concentration, sperm forward motility were significantly increased by 35.59, 40.50, 4.13 and 2.38% , respectively for cocks fed diet supplemented with Nano-Se followed by those having organic Se as compared to those fed the control diet. At the same improvement trend, Nano selenium leads to significantly decrease dead sperms and abnormal sperms by 27.91 and 36.47%, respectively as compared to the control diet (without selenium). The interaction between ambient temperatures and dietary selenium source had no significant effect on some semen physical parameters of local Sinai cocks during the experimental periods (Table 13).

Hatchability traits:

Table (14) showed that the effect of ambient temperatures, dietary selenium source and their interaction on hatchability parameters (%) of local Sinai hens during the early laying stage. Fertility rate was not significantly affected by ambient temperature, but hatchability rate (of all set eggs and of fertile eggs) were significantly decreased by 2.19 and 2.83%, respectively, for hens exposed to high temperature than those reared in thermo-neutral. On the other hand, different sources of selenium had significantly effect on fertility and hatchability rate of laying hens during the experimental period (Table 14). Fertility and hatchability rate were improved significantly by Nano selenium followed by organic selenium as compared with the control group.

The results of the present study are in line with some other researchers who demonstrated that selenium sources help in increasing egg production traits as well as fertility and hatchability (Attia et al., 2010; Canogullari et al., 2010; Waseem et al., 2016a). Interaction between ambient temperatures and dietary selenium sources had significant effect on fertility and hatchability of all fertile eggs except the hatchability of all set eggs which is not significantly affected (Table 14).

Data in Table (14) showed that heat stress resulted in a significant increase of total EM as compared with control group. While, total EM was decreased significantly by Nano selenium. Interaction between ambient temperatures and dietary selenium sources had significant effect on total EM. The best results were recorded with neutral and Nano selenium.

CONCLUSION

The obtained results indicated that heat stress severely reduced productive and physiological performance for Sinai hens, whereas the productive and reproductive performance was improved by dietary selenium sources (Nano Se or organic Se each at 0.3 ppm) supplementation during laying period under heat stress conditions, without any adverse effect on the vitality of hens.

Table (1): Composition and calculated analysis of the basal pre- lay and layer diets fed to local Sinai hens throughout the experiment

Ingredients (%)	**Pre-lay (17 – 20 wks.)**	**Layer (20 – 34 wks.)**
Yellow corn	69.00	68.00
Soy bean meal (44 %)	22.45	22.45
Wheat bran	1.70	0.00
Di-calcium phosphate	1.50	1.50
Limestone	4.70	7.40
Vit & Min. premix[1]	0.30	0.30
Na Cl	0.30	0.30
DL- Methionine (99%)	0.05	0.05
Total	100	100
Calculated Analysis[2]		
Crude protein %	15.47	15.14
ME (Kcal / kg)	2836	2781
Crude fiber %	3.40	3.20
Ether extract %	3.03	2.92
Calcium (%)	2.18	3.20
Av. Phosphorus (%)	0.405	0.398
Methionine %	0.336	0.33
Meth. + Cyst. %	0.600	0.587

[1] Each 3 kg of Vit. and Min. premix contains 100 million IU Vit A; 2 million IU Vit. D3; 10 g Vit. E; 1 g Vit. K_3; 1 g Vit. B1; 5 g Vit. B2; 10 mg Vit. B12; 1.5 g Vit. B6; 30 g Niacin; 10 g Pantothenic acid; 1 g Folic acid; 50 mg Biotin; 300 g Choline chloride; 50 g Zinc; 4 g Copper; 0.3 g Iodine; 30 g Iron; 0.1 g Selenium; 60 g Manganese; 0.1 g Cobalt; and carrier $CaCO_3$ to 3000 g.
[2] According to Feed Composition Tables for animal and poultry feedstuffs used in Egypt (2001).

Table (2): Effect of ambient temperatures, dietary selenium source and their interaction on sexual maturity (SM) and live body weight (LBW) traits of local Sinai hens during the early laying stage (22-34 wks**)**

Main effects \ Traits		SM*		LBW, g		
		1st egg weight, g	Age (days)	Initial (22 wks.)	Final (34 wks.)	Change
Ambient temperatures						
Thermo- neutral (TN)		32.00[a]	127.89[a]	1258.89a	1514.44[a]	255.56[a]
Heat stress (HS)		30.44[b]	124.56[b]	1245.00b	1429.44[b]	184.44[b]
Pooled SEM		±0.24	±0.40	±2.58	±4.53	±3.62
Sig.		***	***	**	***	***
Selenium sources						
Without Se		29.17[b]	130.00[a]	1240.83[b]	1395.83[c]	155.00[b]
Organic Se		31.67[a]	125.17[**b**]	1251.67[ab]	1491.67[b]	240.00[a]
Nano Se		32.83[a]	123.50[b]	1263.33[a]	1528.33[a]	265.00[a]
Pooled SEM		±0.29	±0.49	±3.16	±5.55	±4.44
Sig.		***	***	***	***	***
Interactions between ambient temperatures and Se sources						
TN	without Se	29.33[cd]	131.00	1250.00	1433.33	183.33
	Organic Se	33.00[ab]	126.67	1256.67	1540.00	283.33
	Nano- Se	33.67[a]	126.00	1270.00	1570.00	300.00
HS	without Se	29.00[d]	129.00	1231.67	1358.33	126.67
	Organic Se	30.33[c]	123.67	1246.67	1443.33	196.67
	Nano- Se	32.00[b]	121.00	1256.67	1486.67	230.00
Pooled SEM		±0.41	±0.60	±4.46	±7.85	±6.27
Sig.		*	NS	NS	NS	NS

*On the basis of first egg laid. [2]SEM is based on a pooled estimate of variance.
a,b,c,e,.. : means in the same column within each item with different superscripts are significantly different (p≤0.05).
*= (p≤0.05); **= (p≤0.01); ***= (p≤0.001); NS= non-significant (p>0.05).

Table (3): Effect of ambient temperatures, dietary selenium source and their interaction on egg number and laying rate (%) of local Sinai hens during the early laying periods (weeks of age)

Main effects \ Traits		Egg number/ hen				Laying rate, %			
		22-26	**26-30**	**30-34**	**22-34**	**22-26**	**26-30**	**30-34**	**22-34**
Ambient temperatures									
Thermo-neutral (TN)		16.59[a]	19.82[a]	19.42[a]	55.82[a]	59.23[a]	70.78[a]	69.35[a]	66.46[a]
Heat stress (HS)		16.00[b]	19.44[b]	19.04[b]	54.47[b]	57.15[b]	69.4[b]	67.98[b]	64.85[b]
Pooled SEM		±0.09	±0.09	±0.09	±0.26	±0.31	±0.31	±0.31	±0.31
Sig.		***	**	**	**	***	**	**	**
Selenium sources									
Without Se		14.83[c]	18.98[b]	18.58[b]	52.40[c]	52.98[c]	67.80[b]	66.37[b]	62.38[c]
Organic Se		16.35[b]	19.75[a]	19.35[a]	55.44[b]	58.38[b]	70.52[a]	69.10[a]	66.00[b]
Nano Se		17.70[a]	20.15[a]	19.75[a]	57.60[a]	63.21[a]	71.96[a]	70.54[a]	68.57[a]
Pooled SEM		±0.11	±0.11	±0.11	±0.32	±0.38	±0.38	±0.38	±0.38
Sig.		***	***	***	***	***	***	***	***
Interactions between ambient temperatures and Se sources									
TN	without Se	14.88[d]	19.28	18.88	53.03	53.13[d]	68.84	67.41	63.13
	Organic Se	16.50[c]	19.90	19.50	55.90	58.93[c]	71.07	69.64	66.55
	Nano- Se	18.38[a]	20.28	19.88	58.54	65.65[a]	72.43	71.00	69.69
HS	without Se	14.79[d]	18.69	18.29	51.78	52.83[d]	66.76	65.33	61.64
	Organic Se	16.19[c]	19.59	19.19	54.98	57.83[c]	69.98	68.55	65.45
	Nano- Se	17.02[b]	20.02	19.62	56.66	60.78[b]	71.50	70.07	67.45
Pooled SEM		±0.15	±0.15	±0.15	±0.46	±0.54	±0.54	±0.54	±0.54
Sig.		**	NS	NS	NS	**	NS	NS	NS

a,b,c,.. : means in the same column within each item with different superscripts are significantly different ($p \leq 0.05$).
= ($p \leq 0.01$); ***= ($p \leq 0.001$); NS= non-significant ($p > 0.05$).

Table (4): Effect of ambient temperatures, dietary selenium source and their interaction on egg weight and mass of local Sinai hens during the early laying periods (weeks of age)

Main effects \ Traits		Egg weight, g				Egg mass, g/ hen			
		22-26	**26-30**	**30-34**	**22-34**	**22-26**	**26-30**	**30-34**	**22-34**
Ambient temperatures									
Thermo-neutral (TN)		40.90^{a}	42.04^{a}	45.38^{a}	42.86^{a}	679.54^{a}	833.49^{a}	881.75^{a}	2394.77^{a}
Heat stress (HS)		40.36^{b}	41.56^{b}	44.54^{b}	42.25^{b}	646.42^{b}	808.21^{b}	848.60^{b}	2303.23^{b}
Pooled SEM		±0.07	±0.09	±0.17	±0.10	±4.51	±5.10	±6.64	±16.00
Sig.		***	**	**	***	***	**	**	**
Selenium sources									
Without Se		39.87^{b}	41.01^{c}	43.47^{c}	41.56^{c}	591.34^{c}	778.59^{b}	808.06^{c}	2177.99^{c}
Organic Se		40.36^{b}	41.72^{b}	44.89^{b}	42.43^{b}	659.78^{b}	823.94^{a}	868.55^{b}	2352.27^{b}
Nano Se		41.67^{a}	42.68^{a}	46.52^{a}	43.69^{a}	737.82^{a}	860.01^{a}	918.92^{a}	2516.74^{a}
Pooled SEM		±0.08	±0.11	±0.20	±0.12	±5.52	±6.24	±8.13	±19.60
Sig.		***	***	***	***	***	***	***	***
Interactions between ambient temperatures and Se sources									
TN	without Se	40.11	41.394	44.03	41.97	596.61^{d}	797.87	831.14	2225.62
	Organic Se	40.57	41.768	45.25	42.63	669.52^{c}	831.20	882.39	2383.11
	Nano- Se	42.03	42.962	46.86	43.99	772.49^{a}	871.39	931.70	2575.58
HS	without Se	39.62	40.620	42.91	41.14	586.08^{d}	759.32	784.97	2130.37
	Organic Se	40.14	41.681	44.53	42.22	650.03^{c}	816.69	854.71	2321.43
	Nano- Se	41.31	42.391	46.19	43.38	703.14^{b}	848.63	906.13	2457.90
Pooled SEM		±0.12	±0.15	±0.29	±0.17	±7.80	±8.83	±11.50	±27.72
Sig.		NS	NS	NS	NS	**	NS	NS	NS

a,b,c,e,.. : means in the same column within each item with different superscripts are significantly different ($p \leq 0.05$).
= ($p \leq 0.01$); ***= ($p \leq 0.001$); NS= non-significant ($p > 0.05$).

Table (5): Effect of ambient temperatures, dietary selenium source and their interaction on feed consumption and conversion of local Sinai hens during the early laying periods (weeks of age)

Main effects \ Traits		Feed consumption (g/ hen)				Feed conversion ratio (g F./ g EM)			
		22-26	**26-30**	**30-34**	**22-34**	**22-26**	**26-30**	**30-34**	**22-34**
Ambient temperatures									
Thermo-neutral (TN)		2737.78	2853.97[a]	2937.97[a]	8529.71[a]	4.09[b]	3.43	3.34	3.58[b]
Heat stress (HS)		2700.44	2786.12[b]	2857.68[b]	8344.24[b]	4.21[a]	3.46	3.39	3.64[a]
Pooled SEM		±18.26	±7.38	±4.42	±26.86	±0.03	±0.02	±0.02	±0.02
Sig.		NS	***	***	***	**	NS	NS	*
Selenium sources									
Without Se		2818.67[a]	2910.21[a]	2994.21[a]	8723.08[a]	4.77[a]	3.74[a]	3.71[a]	4.01[a]
Organic Se		2688.00[ab]	2798.21[b]	2868.21[b]	8354.41[b]	4.08[b]	3.40[b]	3.30[b]	3.55[b]
Nano Se		2650.67[b]	2751.72[b]	2831.05[c]	8233.44[b]	3.60[c]	3.20[c]	3.08[c]	3.27[c]
Pooled SEM		±22.36	±9.04	±5.41	±32.90	±0.03	±0.02	±0.03	±0.02
Sig.		***	***	***	***	***	***	***	***
Interactions between ambient temperatures and Se sources									
TN	without Se	2837.33	2951.49	3035.49	8824.31	4.76[a]	3.70	3.65	3.97
	Organic Se	2716.00	2832.31	2916.31	8464.62	4.06[b]	3.41	3.31	3.55
	Nano- Se	2660.00	2778.10	2862.10	8300.21	3.44[d]	3.19	3.07	3.22
HS	without Se	2800.00	2868.92	2952.92	8621.85	4.78[a]	3.78	3.76	4.05
	Organic Se	2660.00	2764.10	2820.10	8244.21	4.09[b]	3.39	3.30	3.55
	Nano- Se	2641.33	2725.33	2800.00	8166.67	3.76[c]	3.21	3.09	3.32
Pooled SEM		±31.62	±12.79	±7.65	±46.53	±0.04	±0.03	±0.04	±0.03
Sig.		NS	NS	NS	NS	**	NS	NS	NS

a,b,c, ,.. : means in the same column within each item with different superscripts are significantly different (p≤0.05).
= (p≤0.01); ***= (p≤0.001); NS= non-significant (p>0.05).
*= (p≤0.05);**

Table (6): Effect of ambient temperatures, dietary selenium source and their interaction on external and internal egg quality of local Sinai hens during the early laying stage

Traits / Main effects		External egg quality			Internal egg quality			
		Shell weigh (%)	**Shell thickness (mm)**	**Egg shape index**	**Albumen weight (%)**	**Yolk weight (%)**	**Yolk index**	**Hough unit**
Ambient temperatures								
Thermo-neutral (TN)		11.72	0.314	77.83	57.48	30.80	46.82	95.37
Heat stress (HS)		12.20	0.320	76.71	57.21	30.59	45.85	95.56
Pooled SEM		±0.229	±0.006	±0.417	±.461	±0.354	±0.506	±.776
Sig.		NS	NS	NS	NS	NS	NS	NS
Selenium sources								
Without Se		11.79	0.312	75.60[b]	57.39	30.82[ab]	45.76	92.78[b]
Organic Se		12.14	0.328	77.50[ab]	58.11	29.75[b]	47.17	95.22[ab]
Nano Se		11.96	0.311	78.71[a]	56.54	31.51[a]	46.08	98.39[a]
Pooled SEM		±0.281	±0.007	±0.511	±0.565	±0.433	±0.619	±0.950
Sig.		NS	NS	***	NS	*	NS	***
Interactions between ambient temperatures and Se sources								
TN	without Se	11.92	0.301	75.53	57.81	30.27	46.04	91.778
	Organic Se	11.74	0.324	78.22	58.16	30.10	47.47	95.667
	Nano- Se	11.51	0.316	79.75	56.46	32.03	46.95	98.667
HS	without Se	11.66	0.322	75.67	56.97	31.38	45.47	93.778
	Organic Se	12.54	0.332	76.78	58.05	29.41	46.88	94.778
	Nano- Se	12.40	0.306	77.66	56.61	30.99	45.21	98.111
Pooled SEM		±0.397	±0.010	±0.722	±0.798	±0.612	±0.876	±1.34
Sig.		NS	NS	NS	NS	NS	NS	NS

a,b,c.. : means in the same column within each item with different superscripts are significantly different ($p \leq 0.05$).
*= ($p \leq 0.05$); ***= ($p \leq 0.001$); NS= Not significant ($p > 0.05$).

Table (7): Effect of ambient temperatures, dietary selenium source and their interaction on rectal temperature (°C) and respiratory rate (breaths/ minute) of local Sinai hens at 24 and 34 weeks of age

Main effects / Traits		Rectal temperature (C°) wk of age		Respiratory rate (min^{-1}) wk of age	
		24	**34**	**24**	**34**
Ambient temperatures					
Thermo-neutral (TN)		42.00[b]	41.58[b]	50.778[b]	45.33[b]
Heat stress (HS)		42.44[a]	42.27[a]	61.667[a]	69.00[a]
Pooled SEM		±0.136	±0.086	±0.837	±0.509
Sig.		*	***	***	***
Selenium sources					
Without Se		42.17	41.73	44.17[c]	53.50[b]
Organic Se		42.17	41.92	66.25[a]	59.25[a]
Nano Se		42.33	42.12	58.25[b]	58.75[a]
Pooled SEM		±0.167	±0.105	±1.03	±0.624
Sig.		NS	NS	***	***
Interactions between ambient temperatures and Se sources					
TN	without Se	42.00	41.60	44.33[c]	43.50[d]
	Organic Se	42.00	41.43	60.00[b]	46.00[cd]
	Nano- Se	42.00	41.70	48.00[c]	46.50[c]
HS	without Se	42.33	41.87	44.00[c]	63.50[b]
	Organic Se	42.33	42.40	72.50[a]	72.50[a]
	Nano- Se	42.67	42.53	68.50[a]	71.00[a]
Pooled SEM		±0.236	±0.149	±1.45	±0.882
Sig.		NS	NS	***	**

a,b,c, ,.. : means in the same column within each item with different superscripts are significantly different ($p \leq 0.05$).
*= ($p \leq 0.05$);** = ($p \leq 0.01$); ***= ($p \leq 0.001$); NS= non-significant ($p > 0.05$).

Table (8): Effect of ambient temperatures, dietary selenium source and their interaction on some blood hematological parameters of local Sinai hens during the early laying stage

Main effects \ Parameters		RBC ($x10^6/mm^3$)	Hemoglobin (g/ dl)	WBC ($x10^3/mm^3$)	Heterophils, %	Lymphocyte, %	H/L ratio
Ambient temperatures							
Thermo-neutral (TN)		5.64[a]	11.33[a]	17.22[a]	18.78[a]	75.11[a]	0.25[a]
Heat stress (HS)		4.73[b]	9.21[b]	15.89[b]	16.78[b]	72.44[b]	0.23[b]
Pooled SEM		±0.089	±0.211	±0.304	±0.333	±0.444	±0.004
Sig.		***	***	**	***	***	**
Selenium sources							
Without Se		4.92[b]	9.57[b]	14.67[b]	16.33[b]	75.67[a]	0.22[b]
Organic Se		4.98[b]	9.93[ab]	17.00[a]	17.67[ab]	74.67[a]	0.24[b]
Nano Se		5.67[a]	11.32[a]	18.00[a]	19.33[a]	71.00[b]	0.27[a]
Pooled SEM		±0.108	±0.258	±0.373	±0.408	±0.544	±0.005
Sig.		***	***	***	***	***	***
Interactions between ambient temperatures and Se sources							
TN	without Se	5.40	10.83	15.00	17.67	76.67	0.23[bcd]
	Organic Se	5.47	10.93	17.67	19.00	76.00	0.25[abc]
	Nano- Se	6.07	12.23	19.00	19.67	72.67	0.27[ab]
HS	without Se	4.43	8.30	14.33	15.00	74.67	0.20[d]
	Organic Se	4.50	8.93	16.33	16.33	73.33	0.22[cd]
	Nano- Se	5.27	10.40	17.00	19.00	69.33	0.27[a]
Pooled SEM		±0.153	±0.365	±0.527	±0.577	±0.770	±0.006
Sig.		NS	NS	NS	NS	NS	*

a,b,c,e,.. : means in the same column within each item with different superscripts are significantly different ($p \leq 0.05$).

*= ($p \leq 0.05$); **= ($p \leq 0.01$);***= ($p \leq 0.001$); NS= Not significant ($p>0.05$).

Table (9): Effect of ambient temperatures, dietary selenium source and their interaction on some blood plasma proteins of local Sinai hens during the early laying stage (at 24 and 34 weeks of age)

Main effects / Parameters		Plasma proteins 24 wk of age: T. Protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)	A/G ratio	34 wk of age: T. Protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)	A/G ratio	HSP70 (µg/ml)
Ambient temperatures										
Thermo-neutral (TN)		5.76^{a}	3.65^{a}	2.10	1.744^{a}	6.59^{a}	3.55^{a}	3.05^{a}	1.164^{b}	1.750^{b}
Heat stress (HS)		5.12^{b}	3.09^{b}	2.03	1.538^{b}	5.29^{b}	2.95^{b}	2.34^{b}	1.264^{a}	1.877^{a}
Pooled SEM		±0.040	±0.040	±0.049	±0.050	±0.041	±0.029	±0.026	±0.017	±0.005
Sig.		***	***	NS	*	***	***	***	***	***
Selenium sources										
Without Se		5.24^{b}	3.16^{b}	2.08	1.529	5.58^{c}	3.07^{b}	2.52^{b}	1.231	1.708^{c}
Organic Se		5.40^{ab}	3.44^{ab}	1.96	1.759	5.94^{b}	3.27^{ab}	2.67^{b}	1.230	1.792^{b}
Nano Se		5.68^{a}	3.52^{a}	2.16	1.635	6.31^{a}	3.41^{a}	2.90^{a}	1.180	1.940^{a}
Pooled SEM		±0.049	±0.049	±0.060	±0.062	±0.050	±0.035	±0.032	±0.021	±0.006
Sig.		***	***	NS	NS	***	***	***	NS	***
Interactions between ambient temperatures and Se sources										
TN	without Se	5.61	3.54	2.07	1.716	6.25	3.35	2.90	1.158	1.650^{d}
	Organic Se	5.62	3.66	1.96	1.873	6.58	3.57	3.01	1.186	1.747^{c}
	Nano- Se	6.05	3.76	2.29	1.644	6.95	3.71	3.23	1.149	1.853^{b}
HS	without Se	4.86	2.77	2.09	1.343	4.91	2.78	2.13	1.305	1.767^{c}
	Organic Se	5.17	3.21	1.96	1.644	5.30	2.97	2.33	1.275	1.837^{b}
	Nano- Se	5.31	3.28	2.04	1.626	5.67	3.11	2.57	1.211	2.027^{a}
Pooled SEM		±0.069	±0.069	±0.084	±0.087	±0.071	±0.050	±0.045	±0.030	±0.009
Sig.		NS	NS	NS	NS	NS	NS	NS	NS	**

a,b,c,.. : means in the same column within each item with different superscripts are significantly different ($p \le 0.05$).
*= ($p \le 0.05$);**= ($p \le 0.01$); ***= ($p \le 0.001$); NS= non-significant ($p > 0.05$).
TP = total proteins; ALB = albumin; GLO = globulin; HSP70 = heat shock protein

Table (10): Effect of ambient temperatures, dietary selenium source and their interaction on some blood plasma metabolites of local Sinai hens at 24 weeks of age

Parameters / Main effects		T. lipids (mg/ dl)	Triglyceride (mg/ dl)	T. cholesterol (mg/ dl)	HDL (mg/ dl)	LDL (mg/ dl)	H/L (%)
Ambient temperatures							
Thermo-neutral (TN)		686.89[b]	109.39[b]	143.75[b]	80.36[a]	84.70[b]	96.01[a]
Heat stress (HS)		851.11[a]	137.40[a]	177.31[a]	61.23[b]	121.64[a]	51.45[b]
Pooled SEM		±8.95	±1.22	±1.00	±0.511	±1.21	±1.25
Sig.		***	***	***	***	***	***
Selenium sources							
Without Se		832.50[a]	133.56[a]	171.62[a]	65.65[c]	115.39[a]	60.76[c]
Organic Se		761.17[b]	123.64[b]	163.96[b]	70.53[b]	103.20[b]	72.62[b]
Nano Se		713.33[c]	113.00[c]	146.00[c]	76.20[a]	90.92[c]	87.80[a]
Pooled SEM		±10.96	±1.49	±1.23	±0.625	±1.49	±1.53
Sig.		***	***	***	***	***	***
Interactions between ambient temperatures and Se sources							
TN	without Se	725.00[c]	116.38[d]	151.24[c]	76.52[c]	94.07[d]	81.42
	Organic Se	692.33[c]	109.65[e]	142.86[d]	80.20[b]	84.07[e]	95.45
	Nano- Se	643.33[d]	102.15[f]	137.15[e]	84.35[a]	75.95[f]	111.15
HS	without Se	940.00[a]	150.73[a]	192.00[a]	54.78[f]	136.71[a]	40.10
	Organic Se	830.00[b]	137.62[b]	185.07[b]	60.87[e]	122.33[b]	49.80
	Nano- Se	783.33[b]	123.84[c]	154.86[c]	68.04[d]	105.89[c]	64.44
Pooled SEM		±15.50	±2.11	±1.74	±0.885	±2.10	±2.17
Sig.		*	*	***	*	*	NS

a,b,c,e,f,.. : means in the same column within each item with different superscripts are significantly different ($p \leq 0.05$).

*= ($p \leq 0.05$); ***= ($p \leq 0.001$); NS= Not significant ($p > 0.05$).

Table (11): Effect of ambient temperatures, dietary selenium source and their interaction on some blood plasma metabolites of local Sinai hens at 34 weeks of age

Main effects \ Parameters		T. lipids (mg/ dl)	Triglyceride (mg/ dl)	T. cholesterol (mg/ dl)	HDL (mg/ dl)	LDL (mg/ dl)	H/L (%)
Ambient temperatures							
Thermo-neutral (TN)		684.03^{b}	124.68^{b}	130.00^{b}	64.04^{a}	88.02^{b}	73.40^{a}
Heat stress (HS)		837.38^{a}	144.91^{a}	160.76^{a}	50.79^{b}	132.34^{a}	38.97^{b}
Pooled SEM		±6.71	±0.575	±0.730	±0.593	±0.452	±0.696
Sig.		***	***	***	***	***	***
Selenium sources							
Without Se		822.05^{a}	140.70^{a}	156.57^{a}	52.86^{b}	121.66^{a}	46.78^{c}
Organic Se		746.53^{b}	136.49^{a}	144.90^{b}	57.28^{b}	108.68^{b}	56.32^{b}
Nano Se		713.54^{b}	127.19^{b}	134.67^{c}	62.11^{a}	100.21^{c}	65.46^{a}
Pooled SEM		±8.22	±0.705	±0.894	±0.726	±0.554	±0.853
Sig.		***	***	***	***	***	***
Interactions between ambient temperatures and Se sources							
TN	without Se	744.79	126.32^{d}	144.00^{d}	62.04^{b}	97.60^{d}	63.57
	Organic Se	668.40	124.92^{de}	130.00^{e}	63.27^{b}	86.00^{e}	73.58
	Nano- Se	638.89	122.81^{e}	116.00^{f}	66.80^{a}	80.47^{f}	83.04
HS	without Se	899.30	155.09^{a}	169.15^{a}	43.67^{e}	145.71^{a}	29.99
	Organic Se	824.65	148.07^{b}	159.81^{b}	51.29^{d}	131.35^{b}	39.05
	Nano- Se	788.19	131.58^{c}	153.33^{c}	57.42^{c}	119.95^{c}	47.88
Pooled SEM		±11.63	±0.996	±1.26	±1.027	±0.784	±1.206
Sig.		NS	***	***	**	***	NS

a,b,c,e,.. : means in the same column within each item with different superscripts are significantly different ($p \leq 0.05$).
= ($p \leq 0.01$); *= ($p \leq 0.001$); NS= Not significant ($p > 0.05$).

Table (12): Effect of ambient temperatures, dietary selenium source and their interaction on some blood plasma constituents of local Sinai hens during the early laying stage (at 24 and 34 weeks of age)

Main effects \ Parameters		24 wk of age			34 wk of age		
		Calcium (mg/ dl)	Phosphor (mg/ dl)	TAOC (mmol/L)	Calcium (mg/ dl)	Phosphor (mg/ dl)	TAOC (mmol/L)
Ambient temperatures							
Thermo-neutral (TN)		9.08^{a}	3.85^{a}	0.970^{a}	9.89^{a}	4.58^{a}	0.882^{a}
Heat stress (HS)		7.32^{b}	3.30^{b}	0.738^{b}	8.47^{b}	3.98^{b}	0.741^{b}
Pooled SEM		±0.073	±0.043	±0.010	±0.088	±0.024	±0.005
Sig.		***	***	***	***	***	***
Selenium sources							
Without Se		7.62^{b}	3.36^{b}	0.787^{b}	8.61^{b}	4.10^{c}	0.767^{c}
Organic Se		8.37^{a}	3.63^{ab}	0.852^{ab}	9.28^{a}	4.28^{b}	0.808^{b}
Nano Se		8.60^{a}	3.75^{a}	0.923^{a}	9.66^{a}	4.47^{a}	0.860^{a}
Pooled SEM		±0.089	±0.053	±0.012	±0.108	±0.030	±0.007
Sig.		***	***	***	***	***	***
Interactions between ambient temperatures and Se sources							
TN	without Se	8.79^{b}	3.76^{a}	0.920^{b}	9.56^{b}	4.39	0.840
	Organic Se	9.19^{a}	3.83^{a}	0.983^{a}	9.89^{ab}	4.59	0.880
	Nano- Se	9.26^{a}	3.96^{a}	1.007^{a}	10.22^{a}	4.77	0.927
HS	without Se	6.45^{e}	2.96^{c}	0.653^{e}	7.66^{d}	3.81	0.693
	Organic Se	7.55^{d}	3.42^{b}	0.720^{d}	8.66^{c}	3.97	0.737
	Nano- Se	7.95^{c}	3.53^{b}	0.840^{c}	9.09^{c}	4.17	0.793
Pooled SEM		±0.126	±0.074	±0.017	±0.152	±0.042	±0.010
Sig.		**	*	*	*	NS	NS

a,b,c,e,.. : means in the same column within each item with different superscripts are significantly different ($p \leq 0.05$).
*= ($p \leq 0.05$); ***= ($p \leq 0.001$); NS= Not significant ($p > 0.05$).
TAOC= total anti-oxidant capacity.

Table (13): Effect of ambient temperatures, dietary selenium source and their interaction on some physical semen parameters of local Sinai cocks during experimental periods

Main effects \ Parameters		Ejaculate volume (ml))	Sperm concentration ($\times 10^6/mm^3$)	Sperm forward motility (%)	Live sperms (%)	Dead sperms (%)	Abnormal sperms (%)
Ambient temperatures							
Thermo-neutral (TN)		0.395[a]	2.56[a]	84.9[a]	93.99[a]	6.01[b]	12.8[b]
Heat stress (HS)		0.322[b]	2.30[b]	83.2[b]	92.51[b]	7.49[a]	14.6[a]
Pooled SEM		±0..007	±0.028	±0.207	±0.153	±0.153	±0.158
Sig.		***	***	***	***	***	***
Selenium sources							
Without Se		0.295[b]	2.00[c]	82.3[b]	92.12[b]	7.88[a]	17.0[c]
Organic Se		0.380[a]	2.50[b]	84.2[a]	93.32[a]	6.68[b]	13.3[b]
Nano Se		0.400[a]	2.81[a]	85.7[a]	94.32[a]	5.68[b]	10.8[a]
Pooled SEM		±0.008	±0.034	±0.254	±0.187	±0.187	±0.194
Sig.		***	***	***	***	***	***
Interactions between ambient temperatures and Se sources							
TN	without Se	0.328	2.13	83.3	93.13	6.87	16.0
	Organic Se	0.424	2.58	85.2	94.03	5.97	12.7
	Nano- Se	0.433	2.99	86.2	94.80	5.20	9.7
HS	without Se	0.262	1.87	81.2	91.10	8.90	18.0
	Organic Se	0.336	2.43	83.2	92.60	7.40	13.8
	Nano- Se	0.366	2.62	85.2	93.83	6.17	11.9
Pooled SEM		±0.011	±0.049	±0.359	±0.265	±0.265	±0.274
Sig.		NS	NS	NS	NS	NS	NS

a,b,c,.. : means in the same column within each item with different superscripts are significantly different ($p \leq 0.05$).
***= ($p \leq 0.001$); NS= Not significant ($p > 0.05$).

Table (14): Effect of ambient temperatures, dietary selenium source and their interaction on hatchability parameters (%) of local Sinai hens during the early laying stage

Parameters، % / Main effects		Fertility	Hatchability of all set eggs	Hatchability of fertile eggs	EEM 1-7 (days)	LEM 8-21 (days)	Total EM 1-21 (days)
Ambient temperatures							
Thermo-neutral (TN)		93.49	82.49[a]	88.08[a]	1.76	10.17[b]	11.92[b]
Heat stress (HS)		93.96	80.68[b]	85.59[b]	2.22	12.19[a]	14.41[a]
Pooled SEM		±0.248	±0.241	±0.230	±0.244	±0.218	±0.230
Sig.		NS	***	***	NS	***	***
Selenium sources							
Without Se		90.09[b]	67.90[c]	75.36[c]	3.54[a]	21.10[a]	24.64[a]
Organic Se		94.88[a]	86.19[b]	90.88[b]	1.46[b]	7.66[b]	9.12[b]
Nano Se		96.20[a]	90.67[a]	94.26[a]	0.97[b]	4.77[c]	5.74[c]
Pooled SEM		±0.304	±0.295	±0.282	±0.299	±0.267	±0.282
Sig.		***	***	***	***	***	***
Interactions between ambient temperatures and Se sources							
TN	without Se	91.30[c]	69.13	75.73[d]	3.33	20.90[a]	24.28[a]
	Organic Se	93.33[b]	86.67	92.86[b]	1.07	6.07[c]	7.14[c]
	Nano- Se	95.83[a]	91.67	95.65[a]	0.87	3.48[d]	4.35[d]
HS	without Se	88.89[d]	66.67	75.00[d]	3.76	21.24[a]	25.00[a]
	Organic Se	96.43[a]	85.71	88.90[c]	1.84	9.26[b]	11.10[b]
	Nano- Se	96.56[a]	89.67	92.86[b]	1.07	6.07[c]	7.14[c]
Pooled SEM		±0.430	±0.417	±0.399	±0.422	±0.378	±0.399
Sig.		***	NS	**	NS	**	**

EEM & LEM = early and late embryonic mortality.

a,b,c, ,.. : means in the same column within each item with different superscripts are significantly different ($p \leq 0.05$).

= ($p \leq 0.01$); *= ($p \leq 0.001$); NS= non-significant ($p > 0.05$).

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الملخص العربي

تأثير مصادر مختلفة من السلينيوم فى العليقة على الأداء الإنتاجى والتناسلى لدجاج سيناء البياض تحت ظروف الإجهاد الحرارى

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[3] معهد بحوث الإنتاج الحيوانى – قسم بحوث تغذية الحيوان – مركز البحوث الزراعية – مصر

أجريت هذه الدراسة لبحث تأثير إضافة مصادر مختلفة من السلينيوم {سلينيوم غير عضوى (كنترول)، سلينيوم عضوى أو نانو سلينيوم} فى العليقة تحت ظروف حرارة الجو الطبيعية أو ظروف الإجهاد حرارى على النضج الجنسى و الأداء الإنتاجى والتناسلى لدجاج السينا المحلى خلال المرحلة المبكرة من إنتاج البيض (22-34 أسبوع من العمر).

استخدم فى هذا البحث عدد 198 طائر (180 أنثى + 18 ذكر) عمر 17 اسبوع ، تم وزن الطيور وتوزيعهم عشوائياً إلى مجموعتين رئيسيتين لدراسة تأثير درجات الحرارة المحيطة بالقطيع (حرارة الجو الطبيعية أو الإجهاد حرارى) ثم قسمت كل مجموعة إلى ثلاث مجاميع فرعية كل منها فى ثلاث مكررات متساوية (فى تصميم عاملى 2 × 3) لدراسة تأثير إضافة مصادر مختلفة من السلينيوم {سلينيوم غير عضوى بمعدل 0,1 مليجرام / كجم عليقه (كنترول)، سلينيوم عضوى (خميرة سلينيوم) أو نانو سلينيوم بمعدل 0,3 مليجرام / كجم عليقة}. وعند 17- 20 أسبوع من العمر تم تغذية الطيور علي عليقة قبل الإنتاج 2 % كالسيوم ثم بعد ذلك على عليقة بياض من 20 إلي 34 أسبوع من العمر. تم تسجيل وزن الجسم واستهلاك العلف وحساب معدل التحويل الغذائى وكذلك العمر عند النضج الجنسى (العمر عند وضع أول بيضة) وتسجيل وزن أول بيضة وأيضاً قياس درجة حرارة جسم الطائر ومعدل التنفس خلال فترة الإجهاد الحرارى وتم تسجيل إنتاج ووزن البيض وحساب كتلة البيض وتقييم جودة البيض وجودة السائل المنوى الطبيعية أيضاً حساب نسبة الخصوبة والفقس من خلال تفريخ ثلاث دفعات تفريخ خلال فترة التجربة. تم أخذ عينات دم لتقدير خصائص الدم الهيماتولوجية، كما أخذت عينات من سيرم الدم لتقدير البروتين الكلى والدهون الكلية والكوليسترول والكالسيوم والفوسفور وأيضاً الدهون عالية الكثافة ومنخفضة الكثافة وتقدير بروتينات الصدمة الحرارية والخواص الضد تأكسدية TAOC. أوضحت النتائج مايلى:

1- أدى الاجهاد الحرارى الى انخفاض وزن الجسم ومعدل الزيادة الوزنية وانخفاض وزن اول بيضه والإسراع من النضج الجنسى ، بينما أدى اضافة النانو سليتيوم والسلينيوم العضوى الى زيادة وزن الجسم وزيادة معدل التغير فى وزن الجسم والإسراع من النضج الجنسى وزيادة وزن اول بيضه منتجه .

2- أدى الإجهاد الحرارى إلى إنخفاض نسبة إنتاج البيض وعدد البيض لكل دجاجة ووزن البيض وكتلة البيض بينما أدى إضافة النانو سلينيوم إلى زيادة نسبة إنتاج البيض وعدد البيض لكل دجاجة وزيادة وزن وكتلة البيض يليه السلينيوم العضوى مقارنة بالكنترول.

3- إنخفض معدل إستهلاك العلف معنوياً وكذلك معدل التحويل الغذائى نتيجة للإجهاد الحرارى، كما أن إضافة النانو سلينيوم إلى العليقة أدى إلى إنخفاض معدل إستهلاك العلف وتحسن معدل التحويل الغذائى ولم يكن هناك تأثير معنوى على التداخل بين درجة الحرارة ومصادر السلينيوم المختلفة.

4- لم يتاثر قياس جودة البيض الداخلية والخارجية بالإجهاد الحرارى بينما أدى إضافة السلينيوم فى صورة النانو أو العضوى إلى حدوث فرق معنوى فى دليل شكل البيضة ووزن الصفار ووحدات هاو.

5- لم تتاثر نسبة الخصوبة بالإجهاد الحرارى بينما حدث إنخفاض فى نسبة الفقس وعدد الإسبرمات الحية وزيادة فى عدد الإسبرمات الميتة والشاذة فى السائل المنوى وأدى إضافة النانو سلينيوم إلى العليقة إلى إرتفاع نسبة الخصوبة والفقس وعدد الإسبرمات الحية.

6- أدى الإجهاد الحرارى إلى زيادة درجة حرارة الجسم وكذلك معدل التنفس خلال 24و34 اسبوع. بينما لم يكن هناك تأثير معنوى لدرجة حرارة الجسم نتيجة إضافة السلينيوم بصوره المختلفة، ولكن حدث فرق معنوى بالنسبة لمعدل التنفس خلال نفس الفترة.

7- إنخفضت قيم هيماتولوجى الدم نتيجة الإجهاد الحرارى بينما أدت إضافة النانو سلينيوم إلى زيادة هذه القيم مقارنة بالكنترول بينما حدث إنخفاض معنوى فى بروتينات الدم نتيجة التعرض للإجهاد الحرارى، فى نفس الوقت فإن إضافة النانو سلينيوم والسلينيوم العضوى حسن من قيم بروتينات الدم.

8- إرتفعت قيم الليبيدات الكلية والتراى جلسرايد والكولسترول و LDL بينما إنخفض كلاً من HDL, H/L خلال فترة التجربة نتيجة التعرض للإجهاد الحرارى، بينما أدت إضافة النانو سلينيوم والسلينيوم العضوى إلى تقليل الدهون الكلية والتراى جلسرايد والكولسترول وLDL بينما زادت قيم HDL,H/L، كما إنخفضت نسبة الكالسيوم والفوسفور ومضادات الأكسدة الكلية نتيجة التعرض للإجهاد الحرارى فى حين أدت إضافة السلينيوم سواء النانو أو العضوى إلى زيادة نسبتهم.

يستنتج من الدراسة أنه يمكن تحسين معدلات الأداء الإنتاجى والتناسلى تحت ظروف الإجهاد الحرارى لدجاج السينا المحلى أثناء فترة إنتاج البيض عن طريقة إضافة السلنيوم بصوره المختلفة سواء الصورة النانومترية أو الصورة العضوية بمعدل 0,3 مليجرام /كجم عليقة دون حدوث أى تأثير ضار على حيوية الطيور.