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AN ATTEMPT TO ALLEVIATE HEAT STRESS OF BROILER CHICKS (DURING SUMMER SEASON) THROUGH STOCKING DENSITY, DIETARY ORGANIC SELENIUM (SEL-PLEX) AND VITAMIN E-SELEMIUM

By

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Abstract: *This study was conducted to alleviate heat stress and to determine the effects of organic selenium (Sel-Plex) and vitamin E selenium (E-Sel) on performance, blood constituents and feathering scores of broiler reared under chronic heat stress during summer season (30.0-43.5°C). A total of 180, one-day-old broiler chicks were randomly assigned to two stocking density and three selenium treatments, with two replicates of 15 birds each. A 3 x 2 x 2 factorial design was used, factors were received vitamin Sel-Plex, E-Sel and basal diet as control, two stocking densities of 10 and 8 bird/m^2. Body weights and feed conversions were determined at hatch, 2, 4 and 6 weeks of age, and mortality was recorded on a daily basis. Scores of feather tracts were scored subjectively on the basis of feather size and skin surface covered at 21, 28, 35, and 42 d of age. Birds received organic selenium (Sel-Plex) in their diets had been improved body weight, feed conversion and livability compared to E-Sel and control groups. Selenium supplementation increased feathering, with organic selenium (selenised yeast) being superior to inorganic selenium (sodium selenite). Sel-Plex induced the fastest whole body feathering. The influence of Sel-Plex was evident from 21 through 42 d of age. Feathering of broilers in the low stocking density was slightly faster than the feathering of broilers in the high stocking density. The levels of triiodothyronine (T_3) and thyroxine (T_4) were significantly lowered in the control group as compared to selenium treatments groups. Plasma concentration of glucose, cholesterol, total protein and globulin were significantly higher in the control group as compared to selenium treatment groups. From this study, it could be concluded that supplementation of organic Se (Sel-Plex) or vitamin E+Se (E-Sel) showed better growth improvement in the performance of broiler* *chicks reared under heat stress and these additives are considered as a protective management practice in broiler diets to alleviate the adverse effects of heat stress under hot climates.*

INTRODUCTION

Broiler production is not widely spread in the south region of Egypt. This area typically show very high temperatures during summer. Vitamins, minerals and drugs supplementation as a single agent or in combination have been suggested to improve performance and immune response to diseases and also to decrease the economic losses related to high temperature, stocking density and food quality (Smart *et al.*, 1985; Latshow, 1991; Bollengier-Lee *et al.*, 1998). Reduction of broiler performance due to high ambient temperature is well established (Lesson, 1987; Cahaner and Leenstra, 1992; Cahaner *et al*,1993).

Several factors such as rapid growth, high temperature and stocking density cause suppression of antioxidant enzymes (Stocker et al., 1986; Levander *et al*., 1989; Rizzo *et al*., 1994; Botije *et al*., 1995). Hill (1992) and Oge *et al*., (1996) stated that vitamin E Selenium were effective in superoxide dismutase (SOD) enzymes of rat and pig.

Selenium supplementation to poultry rations is a routine procedure. Sodium selenite is considered the traditional source of supplementation (Leeson and Summers, 1991). Recently, organic selenium from yeast (Sel-Plex, Alltech Inc.) is more active form of selenium in chickens than selenite (Cantor *et al*., 1975; Collins *et al*., 1993). Thompson and scott (1969), Scott *et al*. (1982) and Leeson and Summers, (1991) have shown that selenium is required for maximum performance of chickens. Mahmoud and Edens (2003) found that chickens fed organic selenium as Sel-Plex, a selenized yeast, had elevated GPX activity in both blood and liver in a thermoneutral environment and after heat distress.

Edens (1996, 1998) reported that feathering rate of auto-sexed, slow feathering males was changed significantly with dietary supplementation of organic selenium (Sel-Plex). Enhanced feathering with Sel-Plex compared to sodium selenite at levels of 0.1, 0.2 or 0.3 mg/kg of diet was observed in trials conducted in both spring and summer seasons. These observations were unexpected even though it had been reported that selenium apparently was involved in feathering and feather development (Supplee, 1966;Thompson and Scott, 1969). Since poor feathering was associated with production of broilers in cages (Andrews *et al*., 1975; Bayer *et al*., 1976).

Sel- Plex,; E-Selenium; feathering scores; blood constituents; broiler.

The purpose of this experiment is to study the effects of some used methods partially alleviate the detrimental effects of heat stress on broiler performance in Upper Egypt.

MATERIALS & METHODS

This study was carried out at the farm of Faculty of Agriculture in Sohag during the period from Jun to August 2005. A 2 x 3 x 2 factorial experimental design was used in this study (2 densities, 3 selenium treatments with 2 replicates of each). One hundred and eighty one day old unsexed Cobb broiler chicks were used. Birds were divided into two groups of 90 birds. The first group was housed as 10 birds per squire meter and the second was housed as 8 birds/m^2 , each group was divided in to three treatments. The first group received the basal diet and supplemented with 0.2 mg/ kg Se (Selenium) in the form of organic selenium or selenium yeast (Sel-Plex). The second group was received the basal diet and supplemented with Vitamin E selenium (E-Sel) in the form of sodium selenite (inorganic selenium) was added to supply 0.2 mg/kg Se. The third group was given the basal diet (yellow corn 61%, Soybean meal (44% CP) 26 %, Gluten (62 %) 9%, Bone meal 22.9%, limestone 0.49 %, Salt 0.4%, Premix 0.34%, lysine 0.33%, Methionine 0.15%).

Brooding temperature and light management within the treatments were consistent with current broiler management practices. Brooding temperature was 95°F (35°C), and this temperature was decreased incrementally (4°F at a time) to 70°F (20°C) by the time the birds were 21 d old. The photoperiod was established at 23 hr light and 1 hr darkness. The litter in all treatments was consisted of wheat strew.

Body weights (BW), feed consumption (FC) and feed conversions ratio (FCR) were determined at hatch, 21 and 42 days of age, and mortality was recorded on a daily basis. Scores of feather tracts on the back (interscapsular cape, dorsal, pelvic, dorsal caudal tracts combined), breast (pectoral and sternal tracts combined), thigh (femoral tract- rear body and lower thigh, combined), neck (dorsal cervical and ventral cervical combined), tail (greater and lesser sickle feathers), and wings (upper coverts) were scored subjectively on the basis of feather size and skin surface covered at 21, 28, 35, and 42 days of age.

Feathering scores ranged from 0, if there were no down feathers, but normally, a score of 1 (poorest) to 5 (best) was assigned for each tract according to (Edens, *et al*., 1999). The regional feathering scores were determined, and scores for the different feather tracts were averaged for a whole body feathering score. Data on feathering were partitioned by dietary Se source, and stocking density.

At 6 weeks of age, blood samples were collected from brachial veins into heparinized tubes, centrifuged at 3000 rpm for 10 min to separate plasma. Plasma samples were stored at -20°C until used for determination of total protein, albumin, glucose, total lipids, T3, T4 by using commercial kits (Bio-Merieux, France). Total lipid, total cholesterol, triglyceride, GOT, GPT were determined in serum by spectrophotometric methods using available commercial kits.

The data from this experiment were analyzed as a completely randomized design to determine the effect of selenium treatments, stocking density and their interaction in whole performance, feathering scores and blood parameters. The statistical analysis was achieved using the General Linear Model procedure of SAS (SAS Institute, 1996) using the statistical model:

$Y_{ijk} = M + T_i + t_j + (T \times t)_{ij} + E_{ij}$

Where M= overall mean.

T_i = the effect of $i^{\underline{th}}$ treatment and i = 1, 2,3 where 1= Sel-Plex supplementation, 2= Vitamin E Selenium and 3 = Basal diet

t_j = the effect of $j^{\underline{th}}$ stocking density and j=1, 2, where 1= 10 birds/m^2 2= 8 birds/m^2

$(T \times t)_{ij}$ = the interaction between selenium supplementation and stocking density.

E_{ij} = Random error.

A probability level of *P*(0.05 or as _ described in the text was considered to be statistically significant. Analysis of variance was conducted for each parameter, and the level of significance was set at a minimum at $P < 0.05$.

RESULTS & DISCUSSION

1- Body weight (BW) and body gain (BWG): The effect of varying density on body weight and BWG is presented in Table (1). Up to 2 weeks of age BW were similar between high and low densities. At 4 weeks of age, body weight was significantly lower with high density of 10 birds/m^2 as compared with the density of 8 birds/m^2. There were significant differences in BWG during the period from 0-6 weeks of age between the two densities. This observation is in agreement with the finding of El-Sheikh (2002), Shanawany (1988), who observed that body weight at 5 weeks declined in linear manner with increased population density or with Weaver *et al*. (1973) who observed that the 4 weeks BW of birds stocked at 0.07 m^2/bird were significantly decreased in comparison with that of lower densities of (0.11m^2/bird). In the current study, a population density of 0.125 m^2/bird resulted in the highest BW at 6 weeks of age, which was significantly greater than at lower density 0.10 m^2/bird (Table 1). This is in agreement of Cravener *et al*. (1992) who found that the density of 0.09 m^2/bird had the highest body weight at 6 week significantly than at higher densities (0.05 and 0.07 m^2/bird) and not significant compared with 0.11 m^2/bird.

Supplementation of birds feeds with inorganic selenium(Sel-Plex) increased BW significantly at 4 and 6 weeks of age and increased BWG during the period from 0-6 weeks of age compared to control group and not significant compared to the supplementation of vitamin E-Sel of birds feeds. Body weights were equivalent between Vitamin E-Se and Sel-Plex fed broilers in both the 10 birds/m^2 and 8 birds/m^2 (Table 1). The increasing of body weight with feeding Sel-Plex may be due to the findings of Mellor (2000) who concluded that selenium plays an important part in regulatory metabolism, in that it plays an essential role in catalysing the formation of thyroid hormone. Organic selenium from yeast (Sel Plex), a more active form of selenium in chickens than selenite (Cantor *et al*., 1975; Collins *et al*., 1993). It is known that selenium enhances the metabolism of thyroid hormones, which are important for normal growth and development (Arthur, 1992). Abaza (2002) reported that the average body weight of birds received 0.2 ppm or 0.5 ppm Se and 200 IU vitamin E exceeded that of the control group by 13% and 14.9%, respectively at six week of age. He added that combining both Se and V. E had more pronounced effect on body weight as compared with each of them. Choct *et al*. (2004) found that birds receiving organic selenium in their diet had improved eviscerated weight, breast yield and reduced drip loss.

Selenium (Sel-Plex or E-Sel) supplementation significantly ($P<0.05$) improved body weight and body weight gain compared to control. This result is in agreement with the finding of Jianhua *et al*. (2000) who concluded that dietary Se improves the growth of broilers because Se is needed to synthesize 5'-Id which catalyses the convrsion of T_4 to T_3. Leeson and Summers (1991)have shown that selenium is required for maximum performance of chickens.

2- Mortality rate: With respect to the effect of flocking density on mortality rates (Table 2), there were no significant differences between the two densities on mortality rates up to 4 weeks of age, However, during the period from 4 to 6 weeks of age the mortality rates increased significantly as density increases. These results are in agreement with the findings of El-

Sheikh (2002) found that mortality rate after 4 weeks of age increased as density increases during summer season, and Imaeda (2000) who found that in summer, the total mortality of birds housed at 18 birds/m^2 were significantly higher than were those of birds housed at 12 and 15 birds/m^2.

There were no mortality differences between selenium treatments up to 4 weeks of age, while during the period from 4 to 6 weeks of age there were a significant differences in mortality rates between Sel-Plex, E-Sel and control. These results indicate that organic selenium led to improving livability more than E-Sel and control, these results may be due to the findings of Surai (1999; 2000; 2000a) and Surai and Dvorska (2001) concluded that a delecate antioxidant balance in the body is an important determinant of chicken health. There are different wayes in which the antioxidant system can be altered or regulated. The most important regulation is the animal response to stress conditions by synthesizing antioxidant enzymes, for example SOD and GSH-Px. However, this response will be effective only if cofactors such as Se for GSH-Px and Cu, Zn and Mn for SOD are available. Therefore, dietary Se is crucial factor regulating GSH-Px activity and the efficiency of the antioxidant system. So, our results are parallel with these findings, because the mortality rate was low with either Sel-Plex or E-Selenium compared to control.

On the other hand, Choct et al., (2004) found that mortality was not influenced by the level and source of selenium in the feed. Edens, 1996, 1998 and Edens et al., 1999 found that there were no mortality differences between Sel-Plex and sodium selenite.

3- Feed consumption (FC) and feed conversion ratio (FCR): Daily feed consumption and feed conversion ratio from hatch to 6 weeks of age is presented in Table (3). Birds housed at 10 birds/m^2 are eating more feed by about 2.88 % than those birds housed at 8 birds/m^2 during the period from 0-6 weeks of age. This is in agreement with Casteel *et al.*, (1994) who found that feed consumption increasing with density increase. In contrast, Balaji *et al*. (1976) El-Sheikh and (2002)found that a reduction in feed consumption as density of birds increased. which may be due to the different of experiment design, the results obtained by El-Sheikh (2002) were presented as an average during summer and winter, while the current results were done at summer only, the results obtained by Balaji *et al*. (1976) were on White Rock at 8 weeks of age, while the current results were on broiler up to six weeks of age.

As shown in Table (3) it could be observed that feed consumption during the period from hatch to markting age (6 weeks) was significantly decreased with Sel-Plex supplementation compared to control and insignficantly decreased compared to E-Sel supplementation. While, FCR was significantly improved by Sel-Plex compared to E-Sel supplementation. The interaction between selenium supplementation and stocking density was not significant. Feed conversion ratios were not significant difference for birds within the 10 birds/m^2 and 8 birds/m^2 even though there were improving in FCR for those birds housed at 8 birds/m^2, the birds in the 8 birds/m^2 showed a 16-point improved FCR (0.16) (Table3). These observations were consistent with earlier observations of broilers given either sodium selenite or Sel-Pelx (Edens, 1996, 1998 and Edens *et al*., 1999). Choct et al., (2004) found that feed intake was not influenced by the source of selenium.

Blood constituents:

In poultry; vitamins, minerals and drugs supplementation as a single agent or in combination have been suggested to improve performance (weight gain and quality) and immune response to diseases and also to decrease the economic losses related to high temperature, stocking density and food quality (Smart et al., 1985; Latshaw Stilborn et al., 1988), as shown in Table (4) it could be observed that the stocking density has significant effect ($P<0.05$) on serum levels of T_3, T_4, GOT,GPT, total lipid, cholesterol, while it has no significant effect on heamoglobine level. The high stocking density led to decreasing the T_3, T_4, GPT, total protein, albumin, globulin and haemoglobine, while it led to increasing GOT, total lipid, cholesterol and glucose. These results indicate that the lowering stocking density (8 birds/m^2) during summer improved thyroid function, liver function and decreasing oxidative stress condition.

As shown in Table (4) it could be concluded that the concentration of T_3 , T_4, total protein, albumin, globulin, GPT were increased significantly ($P<0.05$) with selenium treatments compared to control. Sel-Plex exceed total protein, Albumin , Globulin, Hemoglobin, T_3, T_4 and GP than control by about 24.5, 26.8, 21.7, 14.2, 39.4, 22.4%, and 26.3%, respectively. The corresponding vales with E-Sel were about 12.5, 9.6, 16.2, 10.2, 16.2, 14.7,9.2%, respectively. While glucose, GOT, total lipids and cholesterol were significantly decreased ($P<0.05$) as a result of selenium supplementation by about 8.7, 26.1, 35.4 and 14.9%, respectively with Sel-Plex, the corresponding vales with E-Sel were 6.5, 18.5, 27.6 and 7.3%, respectively. Sel-Plex supplementation superior E-Sel increasing total protein, albumin , globulin, hemoglobin, T_3, T_4 and GP than control by about 10.7, 15.7, 4.7, 3.7, 20, 6.9, and 15.6%, respectively. Sel-Plex decreasing the stress indicators as glucose, GOT, total lipids and cholesterol by about 2.4, 9.4, 10.8 and 8.2%, respectively. Globulin and hemoglobin values were increased but insignificant with selenium treatments compared to control. With comparing organic selenium (Sel-Plex) and E-Sel, it can be observed that under heat stress, organic selenium improved thyroid and liver function more than E-Sel. This improvement may be due to improving feed consumption, absorption and utilization of nutrients. These findings were in similar with that noticed by Jianhua *et al*. (2000) who found that dietary Se supplementation significantly increased plasma 3,5,3'-triiodothyronine (T3) concentration and improved growth, while plasma thyroxine (T4) concentration was decreased. Stocking density and selenium treatments had no significant effect on haemoglobine levels in blood. In addition the results showed that there was no significant effect of Sel-Plex and E-Sel on hemoglobin (HB). This agreed with Romaniiuk *et al*. (1995). Azza El-Sebai (2000) reported that The treatment with Se and/or V.E had a slight effect on serum total protein, albumin, globulin, total lipids and triglycerides, but serum cholesterol increased significantly ($p \leq 0.05$). Combining Se at levels 0.3ppm and 0.5ppm with 100IU V.E increased the cholesterol level by 7.54% and 8.62%, respectively than that of the control group. Selenium and/or V.E treatments did not affect serum AST, while there was a significant ($p \leq 005$) reduction in serum γGT. The interaction effect of both Se and V.E increased the cholesterol level by 7.54% and 8.62% in treatments 4 and 5, respectively, compared to the control. Abaza (2002) reported that the treatment with Se and/or V.E had a slight effect on serum total protein, albumin, triglycerides, glucose and creatinine but serum cholesterol and total lipids were significantly increased. Dietary selenium and V. E significantly reduced serum γGT, however, there was no effect on serum AST activity.

Feathering scores

Data from this experiment showed that organic selenium (Sel-Plex) induced acceleration in the whole body feathering compared to selenium selenite (E-Sel) and control (Figure 1). This influence of selenium yeast was evident at three weeks of age and persisted through six weeks of age. There were highly significant difference between Sel-Plex, E-selenium, and control ($P<0.01$) at all ages. These data show that the low stocking density (8 birds/m^2) had a greater feathering rate than high stocking density (10 birds/m^2) throughout the six weeks of the experiment, the differences between the two densities were highly significant ($P<0.01$) at 3 and 6 weeks of age. Birds at low stocking density and supplemented Sel-Plex were approached full feathering at five weeks of age, but the birds which supplemented sodium selenite and control group were still lagging behind the group which were supplemented Sel-Plex even at six weeks of age.

Data were partitioned to study the feathering rate on different body regions (Figures 2-7). There was an effect of Sel-Plex on **back feathering** at only 21 d of age (Figure 2). At 35 d of age, nearly complete feathering of the backs of birds in low stocking density were evident in groups given either NaSe or Sel-Plex. In high stocking density, back feathering was very low in comparison with low density (Figure 2). However, there was a significant Se yeast effect associated with faster back feathering from 21 through 42 d of age. Full back feathering in low stocking density with Sel-Plex supplementation was evident at 42 d, but neither birds which given E-Se nor control were not fully back-feathered even at 42 d of age.

Breast feathering was slower than back feathering (Figure 3). The slower feathering rate on this body surface, possibly, may be related to the fact that the birds spend a great deal of their time resting on sternal feathers and may actually suffer a feather loss on this region because of increased contact with the litter floor. However, breast feathering, even with Sel-Plex, was still slower. The differences between selenium yeast, E-selenium and control were significant ($P<0.01$) during the period from 4 to 6 weeks of age. The effect of flocking density on feathering scores was pronounced after four weeks of age, the birds in low stocking density were superior than that in high density ($P<0.05$) at five and six weeks of age.

Thigh feathering was slower than back feathering, but faster than breast feathering, (Figure 4). Nevertheless, Sel-Plex and E-selenium in both high and low density was associated with more rapid thigh feathering than was control throughout the experimental period. The lower thigh tracts feathered more rapidly than did the rear body tracts, and the independent temporal feathering of these tracts also appeared to be enhanced by the selenium treatments. The effect of density on thigh feathering was not significant.

Wings feathering was faster in Sel-Plex treated with high and low stocking density than in conspecifics given E-Se or control (Figure 5). This increased feathering rate was evident at 21 d of age and persisted through 42 d of age. Nevertheless, Sel-Plex in both high and low stocking density caused more rapid thigh feathering than did E-selenium and control through six weeks of age. Birds at low stocking density and supplemented Sel-Plex were approached full feathering at five weeks of age, but the birds which supplemented E-selenium and control group were still lagging behind the group which were supplemented Sel-Plex even at six weeks of age.

Neck feathering was delayed and slower than all other regions feather until three weeks of age in all treatments when the first growth of feathers in this region became evident (Figure 6). Females feathered the neck faster than did males. At 21 d to 42 days of age, birds supplemented Sel-Plex showed significantly increased neck feathering than E-selenium and control groups ($P<0.05$), there were no significant differences between feathering rates of high and low stocking density (Figure 6). By 35 d of age, neck feathering was nearly complete in the low density with Sel-Plex and E-selenium, but even at six weeks of age, the high stocking had not attained complete neck feathering.

Tail feathering rates (Figure 7) was stimulated by Sel-Plex as early as 21 d of age and persisted through 42 d of age. Tail feathering in Sel-Plex group was significantly faster than feathering of the tail in the other two groups($P<0.01$). Even though feathering in the high stocking group was slower than low stocking group, there was still significant stimulation of feather growth at 28 d of age in the high stocking density given Sel-Plex ($P<0.05$).

Improvement in feathering with Sel-Plex was seen as early as three weeks of age, and this improvement was evident through six weeks of age. In this case, for summertime feathering, Sel-Plex produced better feathering than did E-selenium and control. These data suggest that the improved feathering was directly related to the improved retention of organic selenium and that selenoamino acids such as selenomethionine or selenocysteine were used for keratin synthesis in feather production thereby sparing the cystine pool in liver and muscle glutathione which is normally used (Goto and Okamoto, 1965; Murphy and King, 1985 and Edens *et al*.,1999). The mechanism associated with increased feathering rates of broiler chickens fed diets supplemented with Sel-Plex has not been established.

Edens, *et al*. (2000) suggested that organic selenium was more readily available for incorporation into the keratin used predominantly in feather growth. Evidence is available to show that there is a significant amount of Se incorporated in the feather (Goede, and Bruin**,** 1984). Selenium cation incorporation into feathers is a possibility, but given the fact that Se easily substitutes for Se in methionine and cysteine (Markham, *et al*., 1980**)**, one has to make the assumption that the feather Se source may be from selenomethionine and selenocysteine (Cummins, and Martin**,** 1967 and Esaki et al., 1979). A proximate analysis of feather proteins revealed that the overall contribution of methionine, cystine, and cysteine was relatively low in relation to the total amino acid content (Harrap and Woods**,** 1964).

Thus, if the Se amino acids were low or even marginally deficient in the diets of chickens, the result could be slow and incomplete feathering. However, selenomethionine is readily utilized as a substrate by enzymes that use methionine, and selenomethionine may be more available than pure methionine (Markham, *et al*., 1980**)**. It has been reported that organic Se as selenomethionine was absorbed more efficiently and was retained better than selenite as a source for intracellular selenium (Shan and Davis**,** 1994). Furthermore, organic selenium is equivalent or even superior to NaSe in terms of gut absorption (Collins, *et al*., 1993) and in the prevention of pancreatic fibrosis (Cantor, *et al.*, 1975). Improvement in feathering rate with organic selenium was observed as early as 21 d of age, and this improvement was evident through 42 d of age.

Because organic Se is retained in tissues to a greater degree than is NaSe-based Se (Shan and Davis**,** 1994; Collins, *et al*., 1993; Cantor, *et al.*, 1975), it stands to reason that during times when there is a demand for feather synthesis, Se yeast would be a better source of Se than NaSe. The OR feed supplementation was reported to facilitate better feathering rates during both cool and hot seasons in slow-feathering males (Edens, *et al*., 2000), and, currently, we find that chicks feathered better when they were fed OR. Selenium is a structural component of the glutathione peroxidase system, which acts as an antioxidant, decreasing numbers of intracellular reactive oxygen metabolites (Tappel,1987). For Se to be effective in the activation of this enzyme system, the NaSe and selenate forms must be converted to the selenide form before selenoproteins are synthesized. Cysteine must combine with selenide to form selenocysteine via a tRNA-mediated process, and this is a very limiting process in mammals (Cummins, and Martin**,** 1967). Selenocysteine then serves as the active precursor of selenoproteins, including glutathione peroxidase. Therefore, it is possible that the improved feathering rate in broilers supplemented with Se yeast may be related to improved antioxidant activity, but this remains to be elucidated.

Choct, et al. (2004). Selenium supplementation increased feathering, with organic selenium (selenised yeast) being superior to inorganic selenium (sodium selenite).

The conclution of this study cleared that performance parameters were improved significantly and affected by adding the organic selenium, where there are an increases ($P<0.05$) in live body weight, gain and feed consumption. Also feed conversion were improved ($P<0.05$), whereas mortality rate was decreased at 35 and 42 days of age as comparing with those other groups. Payne and Southern (2005) reported that daily gain, feed intake, gain:feed, eviscerated and chill weights, carcass yield, breast weight, and moisture loss from the breast were not affected (P< 0.05) by Se supplementation. The major benefit of selenium, is as an antioxidant, preventing damage to cells by oxidative metabolism. Selenium plays an important part in regulating metabolism, in that it plays an essential role in catalyzing the formation of thyroid hormone. Organic selenium improved thyroid and liver function and decreasing the heat stress effect.

The organic selenium supplementation was reported to facilitate better feathering rates during both cool and hot seasons in slow-feathering males (Edens, *et al*., 2000). The same trend was observed in our study, so this point is very important for carcass quality. El-Sheikh (2002) reported that the incidence of vent scabs, scabby hip syndrome, sores and breast blisters were highly significant (P<0.01) during summer season compared to winter season. So the low carcass grade was increase during summer (48.2%) compared winter (29.6%). Therefore, the supplementation of Se yeast, a more active form of Se than NaSe, may suppress the expression of the *K* gene product or it may be facilitating the k^+ gene product, allowing the birds to show more rapid feathering. If this is the case, Se from the OR source could also be affecting the expression of other genes. Additional studies are required to elucidate the mode of action of Se yeast on feathering rates in poultry.

Sel- Plex,; E-Selenium; feathering scores; blood constituents; broiler.

Table (1) Effect of stocking density and selenium treatments on body weight and body weight gain.

	Body weight (g)				Body weight gain (g)			
variables	Hatch	two	Four	Six	0-2	2-4	4-6	Hatch-6
	weeks							
Selenium								
Sel-Plex	43.1	323.3	862.5^{a}	1524.9^{a}	280.1^{a}	539.3	661.6	1482.1^{a}
Vitamin E Sel.	43.1	307.3	815.9^{Ab}	1452..5^{ab}	264.0^{ab}	509.3	633.7	1409.4^{ab}
Control	43.1	298.1	795..9^{b}	1412.4^{b}	254.9^{b}	497.2	612.8	1369.4^{b}
Std. Error	**0.27**	**7.85**	**17.77**	**28.01**	**7.85**	**17.11**	**29.82**	**28.13**
Stocking density								
10 birds/m^{2}	43.1	302.9	801.1^{a}	1423.8^{b}	259.7	497.7	621.7	1380..8^{b}
8 birds/m^{2}	43.1	315.7	847.6^{b}	1500.3^{a}	272.5	532.2	649.4	1457.4^{b}
Std. Error	**0.22**	**6.43**	**14.45**	**22.81**	**6.42**	**13.85**	**24.21**	**22.83**
Probability								
Treatments	NS	NS	*	**	NS	NS	NS	**
Stocking density	NS	NS	*	*	NS	NS	NS	*
Interaction	NS	NS	NS	NS	NS	NS	NS	NS

[a,b,c] Means within a column for each effect with no common superscripts differ significant, based on least significant difference. * P<0.05 **P<0.01, NS= not significant

Table (2) Effect of stocking density and selenium treatments on daily feed consumption (FC) and feed conversion ratio (FCR).

Variable	Feed consumption g feed/bird/day				Feed efficiency g feed/g weight			
	0-2	2-4	4-6	0-6	0-2	2-4	4-6	0-6
	weeks							
Selenium								
Sel-Plex	23.8^{B}	76.0	93.5^{B}	64.4^{B}	1.19^{B}	1.97	2.00	1.83^{B}
E- Sel.	27.5^{A}	80.5	98.8^{A}	68.9^{A}	1.47^{A}	2.21	2.19	2.06^{A}
Control	28.3^{A}	72.3	100.2^{A}	66.9^{AB}	1.54^{A}	2.03	2.30	2.05^{B}
Std. Error	0.71	3.31	1.21	1.13	0.07	0.06	0.09	0.05
Stocking density								
10 birds/m^{2}	24.5^{b}	77.0	101.7^{a}	67.7	1.33	2.16	2.29	2.06^{A}
8 birds/m^{2}	28.5^{a}	75.5	93.3^{b}	65.8	1.47	1.98	2.03	1.90^{B}
Std. Error	0.57	2.7	0.98	0.92	0.06	0.05	0.07	0.04
The interactions								
Sel-Plex x 10 birds	22.5^{d}	75.5	95.0^{c}	64.3^{b}	1.15^{b}	2.02^{ab}	2.14^{ab}	1.91^{ab}
Sel-Plex x 8 birds	25.0^{bcd}	76.5	92.0^{c}	64.5^{ab}	1.23^{b}	1.92^{ab}	1.87^{b}	1.76^{b}
E- Sel x 10 birds	26.5^{cb}	83.0	101.5^{b}	70.3^{a}	1.45^{ab}	2.37^{a}	2.31^{ab}	2.16^{a}
E- Sel x 8 birds	28.5^{b}	78.0	96.0^{cb}	67.5^{ab}	1.49^{ab}	2.06^{ab}	2.07^{ab}	1.96^{ab}
Control x 10 birds	24.5^{dc}	72.5	108.5^{b}	68.5^{ab}	1.39^{ab}	2.10^{ab}	2.44^{a}	2.12^{a}
Control x 8 birds	32.0^{a}	72.0	92.0^{c}	65.3^{ab}	1.70^{a}	1.97^{b}	2.16^{ab}	1.98^{ab}
Std. Error ±	1.00	4.68	1.71	1.61	0.11	0.09	0.13	0.07
Probability								
Treatments	***	NS	**	NS	*	NS	NS	*
Stocking density	***	NS	***	NS	NS	NS	*	*
Interaction	NS	NS	**	NS	NS	NS	NS	NS

[a,b,c] Means within a column for each effect differ significant, based on least significant difference. * $P<0.05$ **$P<0.01$ ***$P<0.001$, NS = not significant

Table (3) Effect of stocking density and selenium treatments on mortality rat.

	Mortality % during			
	0-2 weeks	2-4 weeks	4-6 weeks	0-6 weeks
Selenium				
Sel-Plex	1.43^{a}	1.01^{a}	1.16^{c}	3.60^{a}
Vitamin E Sel.	1.38^{a}	1.13^{a}	1.46^{b}	3.97^{a}
Control	1.56^{a}	1.14^{a}	1.76^{a}	4.46^{b}
Stocking density				
10 birds/m^{2}	1.49^{a}	1.14^{a}	1.80^{a}	4.43^{b}
8 birds/m^{2}	1.42^{a}	1.04^{a}	1.12^{b}	3.58^{a}
Probability				
treatments	NS	NS	**	NS
Stocking density	NS	NS	**	**
Interaction	NS	NS	NS	NS

[a,b,c] Means within a raw for each effect with no common superscripts differ significant, based on least significant difference. * $P<0.05$ **$P<0.01$, NS= not significant

Sel- Plex,; E-Selenium; feathering scores; blood constituents; broiler.

Table (4) Effect of selenium source and stocking density on blood constituents levels

	Stocking density (Sd)			Selenium (Se)				Probability		
	10 birds/m^2	8 birds/m^2	S.E ±	Sel-Plex	Vitamin E Sel	Control	S.E ±	Sd	Se	Sd x Se
Total protein (g/dl)	3.873^{B}	4.752^{A}	0.17	4.781^{A}	4.319^{AB}	3.838^{B}	0.21	**	*	NS
Albumin (g/dl)	2.160^{B}	2.623^{A}	0.11	2.705^{A}	2.337^{B}	2.132^{B}	0.12	***	***	NS
Globulin (g/dl)	1.713^{B}	2.128^{A}	0.13	2.075^{A}	1.981^{A}	1.705^{A}	0.17	*	NS	NS
Glucose (mg/dl)	253.83^{A}	238.11^{B}	4.4	236.6^{B}	242.3^{B}	258.9^{A}	5.39	*	*	NS
Hemoglobin (g/dl)	10.24^{A}	11.62^{A}	0.53	11.55^{A}	11.14^{A}	10.11^{A}	0.66	NS	NS	NS
T_3 (ng/dl)	236.5^{B}	310.6^{A}	19.6	321.8^{A}	268.1^{AB}	230.8^{B}	23.9	**	*	NS
T_4 (ng/dl)	18.57^{B}	22.14^{A}	0.73	22.17^{A}	20.78^{A}	18.11^{B}	0.89	***	**	NS
GOT (u/l)	23.38^{B}	19.61^{A}	0.96	18.66^{B}	20.58^{B}	25.25^{A}	1.18	***	***	NS
GPT (u/l)	38.11^{B}	44.83^{A}	1.85	46.83^{A}	40.50^{AB}	37.08^{B}	2.27	**	**	NS
Total lipids (mg/dl)	223.44^{A}	183.27^{B}	10.7	166.4^{B}	186.4^{B}	257.2^{A}	13.1	**	***	NS
Cholesterol (mg/dl)	131.27^{A}	118.16^{B}	4.18	114.6^{B}	124.8^{AB}	134.6^{A}	5.12	*	*	NS

^{A,B,C} Means within a raw for each effect differ significant, based on least significant difference.

***P<0.001, NS= not significant **P<0.01 * P<0.05

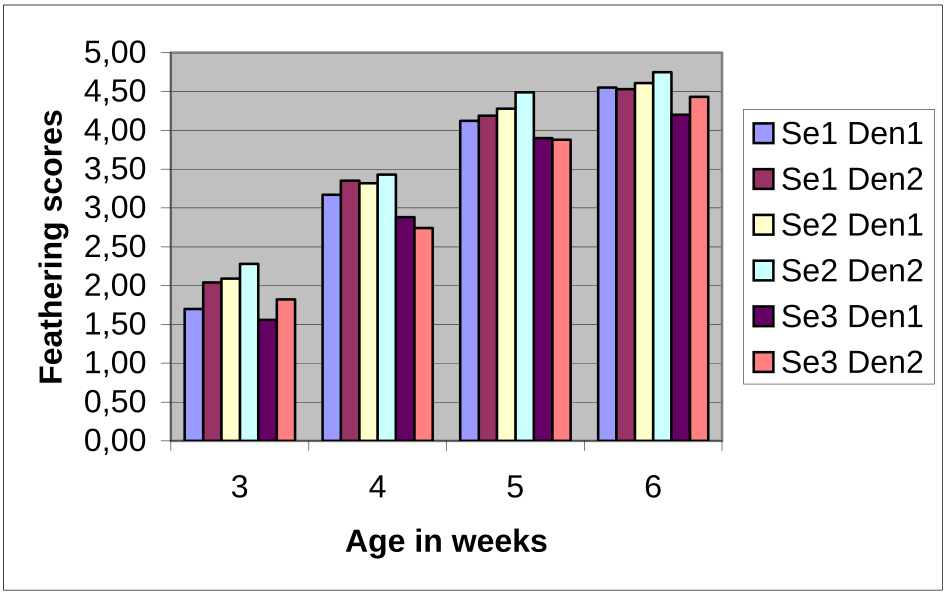

Figure 1. Effect of selenium source and stocking density on whole body feathering in broiler chickens.

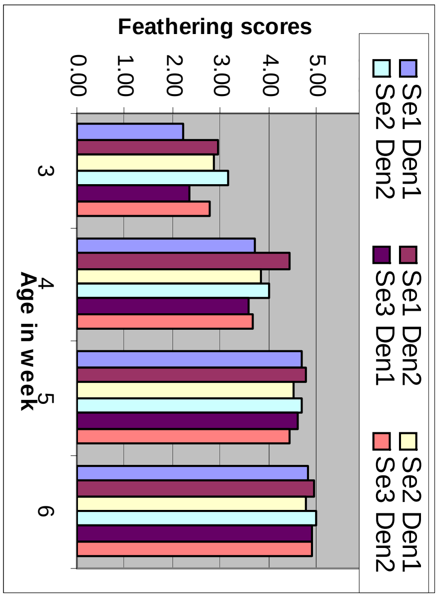

Figure 2. Effect of selenium source and stocking density on back feathering in broiler chickens.

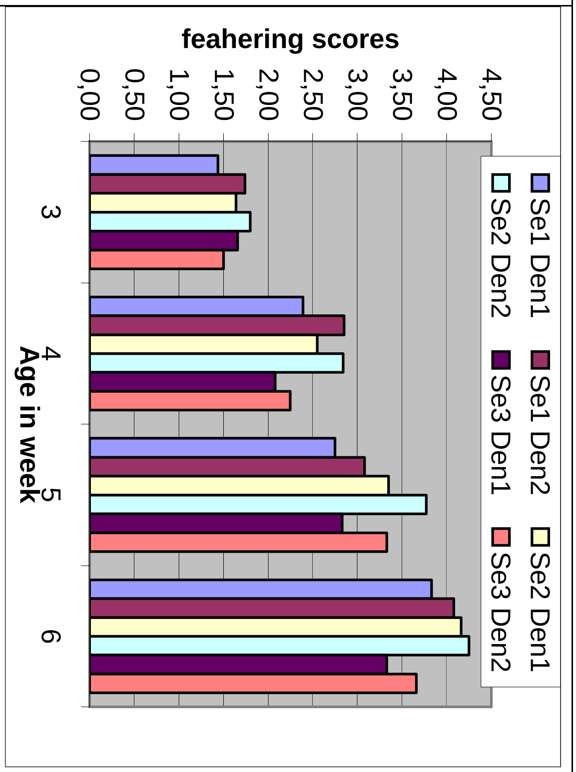

Figure 3. Effect of selenium source and stocking density on breast feathering in broiler chickens.

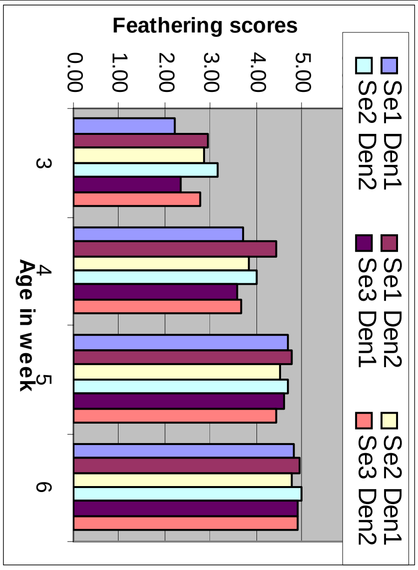

Figure 2. Effect of selenium source and stocking density on back feathering in broiler chickens.

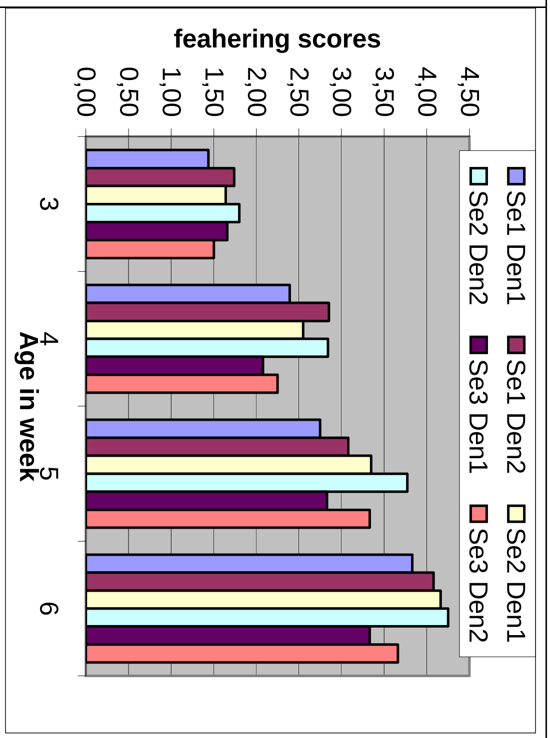

Figure 3. Effect of selenium source and stocking density on breast feathering in broiler chickens.

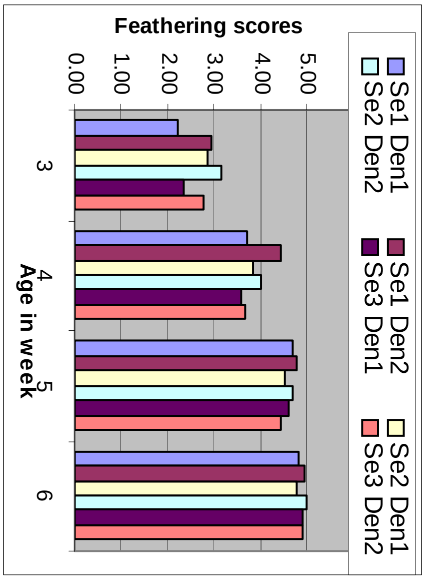

Figure 2. Effect of selenium source and stocking density on back feathering in broiler chickens.

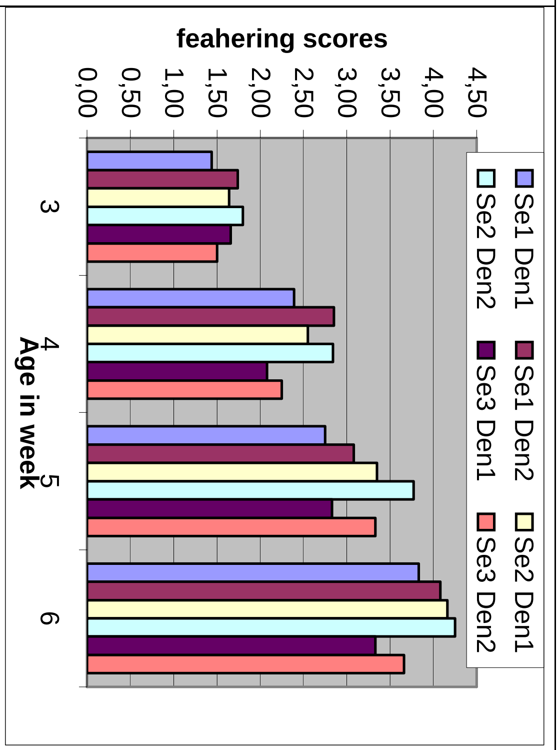

Figure 3. Effect of selenium source and stocking density on breast feathering in broiler chickens.

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Sel- Plex,; E-Selenium; feathering scores; blood constituents; broiler.

الملخص العربى

محاولة لتخفيف الاجهاد الحرارى لبدارى التسمين خلال موسم الصيف عن طريق كثافة الطيور اضافة السلينيوم العضوى وفيتامين هـ سلينيوم الى العليقة.

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اجريت هذه التجربة كمحاولة لتخفيف الاجهاد الحرارى لبدارى التسمين من خلال تأثير كثافة الطيور واضافة السلينيوم العضوى وفيتامين هـ-سلينيوم الى علائق بدارى التسمين خلال فصل الصيف على الاداء الانتاجى ومكونات الدم ومستوى الترييش. استخدم فى هذه التجربة ١٨٠ كتكتوت عمر يوم غير مجنسة وتم تقسيمها عشوائيا الى مجموعتين الاولى بكثافة ١٠ طيور/م٢ والثانية بكثافة ٨ طيور/م٢ وفى داخل كل مجموعة تم تقسيمها الى ثلاثة مجموعات الاولى اضيف لعليقتهاا سلينيوم عضوى والثانية اضيف لها فيتامين هـ - سلينيوم والثالثة لم يضاف لها واخذت كمجوعة كنترول (مقارنة) وبالتالى يكون تصميم التجربة ٢ × ٣ ×٢ (٢ مستوى الكثافة، ٣ معاملات اضافة سلينيوم، ٢ مكررة لكل معاملة) بواقع ١٥ طائر فى المكررة. وتم قياس وزن الجسم عند الفقس، ٢، ٤، ٦ أسبوع وتقدير المستهلك من العليقة يومياً للطائر ومعدل تحويل العلف ونسبة النفوق ومعدل تغطية الريش لاجزاء الحسم المختلفة.

واظهرت النتائج تحسن فى وزن الجسم ومعدل تحويل العلف والحيوية للطيور التى اضيف لعلائقها سواء سلينيوم عضوى او سلينيوم معدنى بالمقارنة بمجموعة الكنترول كما ان المجموعة الى اضيف الى علائقها سلينيوم عضوى كانت اعلى فى وزن الجسم ومعدل تحويل الغذاء والحيوية بالمقارنة بالمجموعة الى اضيف لعلائقها سلينيوم معدنى فى صورة (هـ - سلينيوم) بالاضافة الى ان المجموعة التى اضفيت لعلائقها سلينيوم عضوى كانت اعلى فى غطاء ونمو الريش بالمقارنة بالمجموعتين الاخريين. هذا وقد اظهرت النتائج ان اضافة السلينيوم العضوى ادى الى مقاومة الاجهاد الحرارى بالمقارنة بالسلينيوم المعدنى والكنترول وهذا من خلال تحسن وظائف الغدة الدرقية ووظائف الكبد وانخفاض كلا من السكر والكليستيرول فى الدم. وبالتالى خلصت هذه الدراسة بإمكانية إضافة السلينيوم العضوى الى علائق بدارى التسمين خلال فصل الصيف كطريقة لتخفيف الاجهاد الحرارى.