

PHYSIOLOGICAL RESPONSES OF BROILER CHICKENS AS INFLUENCED BY EARLY AGE HEAT CONDITIONING AND DIETARY ANTIOXIDANT SUPPLEMENTATION

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SUMMARY

Two hundred and forty 1-d old commercial broiler chicks (Cobb) were allotted to two groups of 120 chicks. The first group was the control (Non heat conditioning). The second one was exposed to 40±1°C for 24h at 5 DOA, (early age heat conditioning). Each group was further subdivided into 4 sub-groups of 30 birds each, the first sub-group was control group, the second was fed basal diet supplemented with 200 IU/kg diet vitamin E and 0.8 mg/kg diet chromium methionine, the third was fed basal diet supplemented with 200 IU/kg diet vitamin E and 0.3 mg/kg diet selenium methionine and the fourth was fed basal diet supplemented with 200 IU/kg diet vitamin E, 0.8 mg/kg diet chromium methionine and 0.3 mg/kg diet selenium methionine, to investigate the effects of early age of heat conditioning and some antioxidants supplementation on some physiological changes. Results showed that Chicks exposed to early age heat conditioning recorded significantly higher ($P < 0.05$) BW, BWG, FI and FCR compared with non heat conditioning chicks at 21 and 42 DOA. There were significant ($P < 0.05$) effects of dietary supplements on BW, BWG, FI and FCR at 21 and 42 DOA, and also by the interaction between early age heat conditioning and dietary supplements. Early age heat conditioning had significant ($P < 0.05$) effect on Hb, HT, RBC'S, MCHC and MCV levels at 21 DOA, but MCH values was insignificantly influenced. Significant ($P < 0.05$) effects of early age heat conditioning significant ($P < 0.05$) effects on Hb, HT, and RBC'S levels of broiler chicks at 42 DOA, however, MCH, MCHC and MCV levels were not affected. Dietary supplements (regardless early age heat conditioning) significantly increased Hb, HT, RBC'S, MCH, MCHC and MCV levels at 21 DOA and at 42 DOA except MCH, MCHC and MCV which were not significant. The interaction between early age heat conditioning and dietary supplements was significant for most of the hematological parameters studied either at 21 or 42 DOA. Early age heat conditioning had a significant ($P < 0.05$) effect on H/L ratio, but the effect of dietary supplements alone was not significant at 21 and 42 DOA. Based on the results of the present study it is concluded that early age heat conditioning of broiler chicks and dietary supplements by Vit.E; organic chromium or organic selenium in combination could be recommended for alleviating the negative effects of heat stress during the summer season, on broiler chicks performance.

Keywords: *Broiler, performance, Blood, early age heat conditioning, Vitamin E, selenium, Chromium.*

INTRODUCTION

Poultry production in tropical countries is affected by many challenges especially during the hot humid summer season. High ambient temperature as encountered in Egypt and many other countries during the summer season can generate a state of stress and evokes a combination of behavioral, biochemical and physiological changes. This generally resulted in economic losses by reduction in broiler performance and increased mortality due to acute heat stress. Homeostasis is constantly challenged by intrinsic and extrinsic stressors (Lin *et al.*, 2006). Heat stress is of major concern for poultry industry, especially in the hot regions. The important traits governing productivity (growth performance, immune suppression and high mortality rate etc) are adversely affected by heat stress (Mujahid *et al.*, 2006, 2008 and Niu *et al.*, 2009). Physiological events associated with hyperthermia can potentially promote reactive oxygen species formation which results in the disturbance of balance between the oxidation and antioxidants defense systems, causing lipid peroxidation (LPO), in cell membranes, free radical peroxidation and oxidative injury in biological molecules, DNA and proteins (Lin *et al.*, 2006; Mujahid *et al.*, 2006 and 2007 and Aslam *et al.*, 2010). Further more, 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 requirement, several methods are available to alleviate the negative effects of heat stress, mostly focused on dietary manipulation.

Presently a number of programmers have been used to introduce simplified and practical techniques to alleviate the adverse effects of heat stress in broiler chickens. One of the practical approaches that have yielded promising results is altering birds' abilities to cope with high ambient temperatures by early-age heat conditioning; converging evidence suggests that stressful experiences during the neonatal stage can

have considerable impact on various facets of an animal's physiology and behavior. Exposure of 5-d-old broiler chicks to elevated temperature improved their survivability at 42 DOA after environmental exposure (El-Moniary *et al.*, 2010; El-Wardany *et al.*, 2012 and Hemid *et al.*, 2013).

Dietary chromium supplementation has been reported to have a positive effect on growth rate and feed efficiency of growing poultry under stress conditions (Sahin *et al.* 2001 and Lien *et al.* 1999). Stress thus may exacerbate a marginal chromium (Cr) deficiency or an increased Cr requirement, Cr is used in the poultry diet because of the reported benefits of Cr supplementation in broiler under heat stress because of the fact that stress condition increase chromium mobilization from the tissues that is irreversibly excreted (Sahin *et al.*, 2002 and 2003). Cr plays a regulatory role in insulin action and consequently, in nutrient metabolism (Sands and Smith, 2002). It is also an integral part of bimolecular such as glucose tolerance factor and chromodulin, a cofactor of certain enzymes and necessary for stabilization of proteins and nucleic acids. Ghazi *et al.*, (2012) studied the effect of different concentrations of organic and inorganic chromium on broilers they found the dietary supplementation of both organic and inorganic chromium significantly improved H/L ratio.

Selenium supplementation especially at 0.2 and 0.3 mg/ kg diet significantly ($P \leq 0.05$) increased live body weight of chicks (El-Sheikh *et al.* 2010 and Zhou and Wang 2011). In contrast, Patton *et al.* (2002) suggested that adding selenium yeast at 0.1, 0.2 or 0.3 ppm, was not significantly ($P < 0.05$) affected feed intake. Similar results were observed by (Spears *et al.*, 2003; Jiakui and Xiaolong 2004; Utterback *et al.* 2005 and Ševčíková *et al.*, 2006). El-Sheikh *et al.* (2010) stated that, selenium supplementation especially at 0.2 and 0.3 mg/ kg diet significantly ($P \leq 0.05$) increased blood hemoglobin (Hb) and red blood cells (RBC's) for groups fed 0.2 and 0.3 selenium compared with the control group.

Vitamin E (Vit.E) were discovered and its role as an antioxidants was further characterized (Wolf, 2005). The Vit.E that is integrated into cellular membranes exerts its antioxidant effects by intercepting peroxy radicals more rapidly than can polyunsaturated fatty acids (Burton and Traber, 1990). Abdokalykova and Ruiz-Feria (2006) found that body weight was higher when broilers fed on feed supplemented with vitamin. Elaroussi *et al.* (2007) reported that quail chicks fed on diets containing 0, 1, 5 or 10 times the NRC 12 and 25 mg/kg diet recommended supplements of vitamin E, Significant differences between the 4 dietary treatments indicated that as the levels of vitamin E increased, the percentage of erythrocytes haemolysed activity decreased, whereas Hb concentration increased, they concluded that diet contains in quail chicks 5 times the recommended NRC for vitamin E was adequate to increase Hb concentration.

Therefore, the objective of the present study were to evaluate the effect of different approaches (early age heat conditioning; increasing dietary levels of organic chromium, organic selenium and Vitamin E) on productive performance and some hematological parameters of broiler chicks reared under summer stress conditions. Finally, results from this study could provide a fundamental knowledge for using early age heat conditioning and dietary supplements by Vit.E; organic chromium or organic selenium in combination to reduce improve productive performance and some hematological parameters of broiler chicks under hot climates of summer season in Egypt.

MATERIALS AND METHODS

Experimental procedures

A total of 240 one day old commercial broiler chicks (Cobb) were obtained also from the previous hatchery. They were divided into two groups of 120 chicks. Each group was subdivided into 4 sub-groups of 30 chicks, the first sub-group was the control group, the second was fed basal diet supplemented with 200 IU/kg diet vitamin E and 0.8 mg/kg diet chromium methionine, the third was fed basal diet supplemented with 200 IU/kg diet vitamin E and 0.3 mg/kg diet selenium methionine and the fourth was fed basal diet supplemented with 200 IU/kg diet vitamin E, 0.8 mg/kg diet chromium methionine and 0.3 mg/kg diet selenium methionine. At 5 day of age the first group was exposed to $40 \pm 1^\circ\text{C}$ for 24h (Heat conditioning, HC), while the second one was kept at the normal brooding ($32 \pm 1^\circ\text{C}$) temperature (Non heat conditioning, N.H.C). At 42 DOA all groups were exposed to $41 \pm 1^\circ\text{C}$ for 1h. Feed and water were offered ad libitum and artificial light was provided (23 h day) allover the experimental period. Chicks of the two experiments were kept under similar hygienic and environmental conditions. Composition and calculated analysis of the experimental diets are shown in Table (1); the Temperature-Humidity Index (THI) was calculated using the following formula (World Meteorological Organization (W.M.O), 1996), to determine the level of stress by using the Table (2) which explained Temperature Humidity index ranges and their corresponding stress categories (Smith *et al.*, 1998).

$$THI = T_d - [0.55 - (0.55 * RH/100)] * (T_d - 58).$$

Where;

THI = Temperature Humidity Index;
 T_d = dry bulb temperature in degrees Fahrenheit;
 RH = relative humidity (%).

Table (1). Composition and calculated analysis of the experimental diets.

Ingredient	Starter % 1-21 D	Grower % 22-42 D
Yellow corn	55.35	60.45
Soybean meal (44%)	27.5	25
Corn gluten meal (62%)	8.9	6
Mono-Ca phosphate	1.65	1.6
Limestone	1.7	1.65
Vegetable oil	3.7	4.15
Salt	0.45	0.4
Methionine	0.15	0.15
Lysine	0.3	0.3
Vitamin and mineral mixture	0.3	0.3
Total	100	100
Calculated analysis		
ME kcal/kg	3143	3190
Crude protein %	22.77	20.31
Lysine %	1.27	1.19
Methionine %	0.55	0.51
Methionine+ Cystine %	0.93	0.85
Calcium %	1.00	0.97
Av.Phosphorus %	0.47	0.47

*: Vitamin and mineral mixture per kg of diet: Each kilogram of diet contains = VA, 12000 I.U., D3, 2500 I.U., E, 10mg., B1, 2mg., B2, 5mg., B6, 4mg., B12, 10µg., Niacin, 25mg., Pantothenic acid, 10mg., Biotin, 50µg., Folic acid, 1000µg., and Coline chloride, 255mg. Selenium, 300µg., Copper, 10mg., Iodine, 1.0mg., K, 2.0mg., Iron, 33mg., Manganese, 60mg. and 60mg. Zinc.

The experimental diets and their calculated analysis are shown in Table (3). Feed and water were offered *ad libitum* and artificial light was provided for 23 hours daily allover the experimental period, which lasted for 6 weeks. Chicks of the four treatments were kept under similar hygienic and environmental conditions and vaccinated against common diseases.

Table (2): In door maximum and minimum Temperature (°F), relative humidity and Temperature Humidity index.

Age (Week)	Minimum Temperature(°F)	Maximum Temperature(°F)	Relative humidity(%)	THI min.	THI max.
1	88.18	94.78	68.94	83.02	88.5
2	85.01	92.57	70.40	80.6	86.9
3	85.44	93.58	71.41	81.1	87.9
4	85.75	97.70	73.55	81.7	91.9
5	86.20	99.32	73.63	82.1	93.3
6	86.94	100.76	77.42	83.3	95.4

Table (3): Temperature Humidity index ranges and their corresponding stress categories.

Stress Category	THI range (inclusive)
No stress	<72
Mild stress	72-79
Heat stress	80-89
Severe stress	90-98
Death	>99

Measurements

Chicks were weighed at 1, 21 and 42 days of age (DOA). Body weight (BW) was recorded to the nearest 0.1g. The average body weight gain (BWG) was calculated by subtracting the average of initial body weight of the birds in a certain stage from the final one in the same stage. Feed intake was recorded to the nearest 0.1g and then the feed conversion ratio (FCR) was calculated as gram feed to gram body weight gain.

Blood samples were collected from birds at 21 and 42 DOA during their exanguination into Wasmann plastic tubes and Hemoglobin (Hb), hematocrit (HT), red blood cell count (RBC), hemoglobin mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), hemoglobin mean corpuscular volume (MCV) and heterophils to lymphocytes ratios (H/L ratio).

Hemoglobin (Hb) values as g/100ml. of whole blood were determined by cyanomethemoglobin method using commercial kit purchased from Spectrum Diagnostics Cairo, Egypt, as described by Tietz (1990). Red blood cell count (RBC) were performed by the method described by Natt and Herrick (1952), The blood samples were pipetted in heparinized microhematocrite tubes, centrifuged at 3000 r.p.m for 15 minutes and the hematocrite (Ht) percent was recorded, hemoglobin mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), hemoglobin mean corpuscular volume (MCV), were calculated depended on Hb, RBC and Ht. Blood smears were also done, stained with Wright's stain procedure and used to calculate the number of lymphocytes (L) and heterophils (H) in 100 white blood cells, and then the H/ L ratio was calculated.

At the end of period (42 day of age), three birds from each treatment group were randomly taken, weighed and slaughtered. Feathers were manually removed and eviscerated, weights of Carcass, thigh, breast, liver, heart, gizzard and abdominal fat were also recorded to the nearest 1 gram and thymus, bursa and spleen were weighted and recorded to the nearest 0.01 gram.

Statistical analysis for all measured parameters was performed using the general linear model (GLM) produced by the Statistical Analysis Systems Institute (SAS, 2009).

RESULTS AND DISCUSSION

Productive performance

Results concerning the effect of different treatments on body weight BW and body weight gain BWG at 21 and 42 DOA of broiler chicks are illustrated in Table (4). Significant treatment differences ($P < 0.05$) in favor of early age heat conditioning, were recorded for both final BW and BWG at 21 and 42 DOA compared with the non heat conditioning group. Concerning dietary supplements, the present data show that there were significant ($P < 0.05$) increases effect in BW and BWG at 21 and 42 DOA. The best BW and BWG values were recorded for the vitamin E + organic selenium followed by vitamin E + organic chromium and then vitamin E + organic selenium+ organic chromium compared with the control. It appears from these results that Vit.E plus Se or Cr could act synergistically to stimulate factors that enhance growth performance of broilers. The effect of interaction among dietary supplements and early age heat conditioning was also significant for both BW and BWG with the best values recorded for Vit.E + Se and Vit.E + Cr under early age heat conditioning at the final stage of the experiment (42 DOA). The effect of different treatments on feed intake and feed conversion ratio are presented in Table 5. It is generally observed that, regardless supplements, feed intake was significantly ($P < 0.05$) increased in the heat conditioning groups than non-heat treated ones at periods from 1 to 21 DOA, 21 to 42 and 1 to 42 DOA. A similar trend was obtained for dietary supplements groups, which showed that there were significant ($P < 0.05$) differences in feed intake at periods from 1 to 21 DOA, 21 to 42 and 1 to 42 DOA. Dietary supplementation with Vit.E and Se increased feed intake of chicks with a similar increase in Vit.E and Cr group during the whole experiment period. Concerning feed conversion ratio, the present data illustrated that, there were insignificant effect of early age heat conditioning on feed conversion ratio during the period from 1 to 21 DOA, however this effect was significant during the periods from 21 to 42

and 1 to 42 DOA. Concerning dietary supplements, the present data show that there were significant treatment ($P < 0.05$) effects on feed conversion ratio at 1-21 DOA, 21-42 and 1-42 DOA. The best FC ratio was recorded for birds fed the dietary supplements compared with control. The interaction between early heat conditioning and dietary supplements was significant ($P < 0.05$) for the studied periods. The improvement in productive performance was more obvious when dietary supplements is combined with early age heat conditioning by exposing chicks to $40 \pm 1^\circ\text{C}$ for 24h at 5 DOA. It is clear from the results that Vit.E supplements, showed the greatest improvement in the production performance of broilers. This was also observed in the early age heat conditioning chicks. This may be due to the role of Vit.E in alleviating the negative effects of heat stress on productive performance of birds. Since, the present exp. was done during the hottest months of summer season. The present results are in close agreement with Leshchinsky and Klasing, (2001); Siegel *et al* (2001); Sahin *et al* (2002) and Abdukalykova, and Ruiz-Feria (2006), who reported positive effects of Vit.E on productive performance of different avian species. However, other workers found that Vit.E had no effect on productive performance traits (Amiri *et al* 2006; Boa-Amponsem, *et al* 2006 and Biswas *et al* 2007).

The role of organic Se in enhancing the productive performance of broilers may be related to its role in improving Insulin- Growth factors bioactivity (Moreno *et al* 2001) modulation of somatic growth and thyroid gland activity and improving nutrients metabolism (Surai, 2006; Jiang *et al.*, 2009; Hanafy *et al.*, 2009 and El-Sheikh *et al.*, 2010). In this respect, Helmersson *et al.*, (2005) reported a positive correlation between Se levels and IGF-I and some seleno enzymes, activity. However, some investigators have reported that organic Se supplementation did not affect body weight and daily gain of broilers (Patton *et al*, 2002 and Spears *et al* 2003) but Sahin *et al.*, (2008) found that Se addition to quail diets increased body weight under heat stress conditions.

The beneficial effects of Cr supplementation to poultry diets was explained by its essential in potentiating the action of insulin through the presence of Cr in the glucose tolerance factor and activating some enzymes and stabilizing proteins and nucleic acids (Sahin *et al* 2001).

Concerning early age heat conditioning, results reflect the capability of birds to compensate for growth retardation (associated with heat stress) by different means including physiological and endocrinological mechanisms. It may be the hypothalamic set point of body temperature was changed by increasing the threshold core-temperature for heat production and/or heat loss, since the potential of thermotolerance can thus be improved. It is hypothesized that early age stressors (heat, malnutrition, disease, vaccination... etc) are associated with some responses including growth retardation followed by long term compensatory growth which resulted in higher BW coincided with higher feed intake and improvement in feed conversion ratio. These results are in close agreement with those reported by Zulkifli, *et al.* (2002) and El-Moniary *et al.* (2010).

The combined effect of both Se; Vit.E and early age heat conditioning was more effective in improving productive performance under the prevalent experimental conditions. Since Se is involved in the recycling of Vit.E through the seleno-enzyme thioredoxin reductase, which recycles ascorbic acid and, in turn, promotes the recycling of Vit.E (Surai, 2002; Surai, 2006; Skřivan *et al.*, 2008).

Hematological parameters

Results concerning the effect of early age heat conditioning and some dietary supplements on hemoglobin (Hb), hematocrit (HT), red blood cell count (RBC'S), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), mean corpuscular volume (MCV) and heterophils to lymphocytes ratios (H/L ratio), are presented in Tables (6 and 7). It is clear that early heat conditioning of broiler chicks at 5 DOA has significantly improved their hematological parameters at 21 DOA (Table 6). At 42 day of age the same trend was observed where early heat conditioning had significant ($P < 0.05$) effects on Hb, HT, and RBC'S levels, however MCH, MCHC and MCV values did not significantly affected. Concerning dietary supplements; regardless heat conditioning, the present data show significant effects of feed supplements on the overall mean of the hematological parameters, where there were significant increases in Hb, Ht, RBC'S, MCH, MCHC and MCV values at 21 day of age (Table 6), at 42 DOA except for MCH, MCHC and MCV which were not significant (Table 7). The interaction between early age heat conditioning and dietary supplements on hematological parameters was significant ($P < 0.05$) at 21 and 42 DOA except the MCH and MCHC values which were insignificant at 42 DOA. Results showed also that early age heat conditioning of broiler chicks has a significant effect on H/L ratio either at 21 or 42 DOA (Table 6 and 7) with the lowest ratio being recorded for HC chicks. This was not the case for the influence of dietary treatments on the H/L ratio at the same ages. However, the interaction between HC and dietary supplements was significant with the lower ratios for HC group compared with the NHC treatment. It is clear from the present results that dietary supplements and early age heat conditioning treatment improved the hematological parameters of chicks. This response was also observed for chicks of the early age heat conditioning regardless the dietary supplements. This technique

was approved as a sensitive process to induce thermotolerance at an early age of broiler (3-5 days). In this respect many researches proposed early age heat conditioning as a management technique to reinforce the resistance of broiler chicks to acute heat stress or sudden heat spells during finishing period (Yahav *et al.*, 2004 and 2005; Ali and Hossain, 2010; El-Wardany *et al.*, 2012 and Hemid *et al.*, 2013).

The present results are in agreement with those Ahmed and Reddy (2012); El-Moniary *et al.*, (2010) and Hemid *et al.*, (2013), who found that the hematological responses to acute or chronic heat stress include changes in RBC'S count, Hb and Ht levels and leucocytes differential count, especially heterophils and lymphocytes.

Muller., (2010) found that vitamin E and selenium, improved the blood parameters where vitamin E works to protect phospholipids of cellular and sub cellular membranes, by preventing the oxidation of fatty acids. This antioxidant effect of vitamin E is efficient in high concentrations of oxygen and therefore is concentrated in red blood cells and membranes.

Data showed that, hemoglobin level was decreased significantly and hematocrit tended to increase in broilers fed supplemental Cr. Wilson (1971) reported that some hematology parameter (i.e. Hb; Ht;...) may be used to diagnose both quantitative and morphologic physiological alterations that might be associated with heat stress. According to Kubena *et al.* (1972) exposure of chickens to high temperatures causes a increase in blood hematocrit and hemoglobin values. In addition Toghyani *et al.*; (2006) reported that Cr supplementation increased hematocrit of stressed animal.

There is evidence that both Vit.E and Se plays a major role in protecting living cells from damage and this protection was achieved via better and healthy hematological and immunological responses, which is the case in the present study. This holds true as Surai, (2002 and 2006) stated that Se deficiency in chickens, especially when combined with low Vit.E supply, is responsible for a range of diseases due to mal function of different organs. It may be also that Se can improve nutrients utilization due to its antioxidant properties which protect nutrients and vitamins (fat- soluble vitamins) from oxidation. This was proved by (Yang, *et al* 2012).

Carcass characteristics and some organs weight

The overall means of carcass weight (%) and the relative weights of some body organs are presented in Tables (8 and 9). It is clear that early age heat conditioning had significantly ($P<0.05$) increased the relative weights of carcass; breast; thigh; gizzard; heart; abdominal fat and thymus gland with an insignificant effect on bursa of Fabricius and spleen. However, liver (%) was significantly decreased. Concerning dietary supplements, results showed the relative weight of carcass; breast muscles; thigh; gizzard and heart were significantly increased, regardless early age heat conditioning treatment. On the other hand, the relative weight of liver was significantly ($P<0.05$) decreased by dietary supplements. Moreover, the relative weights of abdominal fat; bursa; thymus and spleen were not significantly affected. The interaction effect between early age heat conditioning and dietary supplements on studied traits was significant except for the lymphoid organs. The results indicate that dietary supplements have well improved carcass characteristics, and this may be due to that broilers are able to compensate the retardation of growth by different magnitudes including the well documented relationships between the dietary supplements and some endocrine functions which include the stimulatory effects of Vit.E; Se and Cr. on thyroid gland activity insulin hormone production under heat stress conditions. In accordance with the results of the performance data in the present study it has been suggested that carcass trait were also affected by different feed supplements may regulate some endocriental function and acts as antioxidants which in turn protect dietary nutrients and body tissue from oxidative stress. These results are consistent with Yahav *et al.*, (1997); Yahav and Plavink (1999); Sahin *et al.*, (2002); and Surai (2002).

In the present study Cr supplementation has insignificant effect on abdominal fat which in agreement with the result of Lien *et al.* (1999), but is in incoherence with those of Ward *et al.* (1993), Hossain *et al.* (1998) and Sahin *et al.* (2003). They may be due to the role played by Cr in insulin secretion and its metabolic effects.

Concerning early age heat conditioning of chicks, showed body and breast muscle weights were greater in heat conditioning chicks vs. their untreated counterparts at later ages which confirm the results of Yahav (1998 and 2000) and Yahav and Hurwitz (1996). The present results focused on the early events of postnatal skeletal muscle development that lead to enhanced hypertrophy at later ages. The results showed for the first time that mild heat exposure, at an early age has a stimulatory effect on skeletal muscle growth due to an immediate increase in satellite cell proliferation followed by accelerated differentiation, this support the findings by Yahav *et al.*, (2004); El-Moniary *et al.*, (2010); and Hemid *et al.*, (2013).

Table (4). Effect of some dietary supplements and early age heat conditioning on Body weight (BW) and body weight gain (BWG) of broiler chicks at different ages.

Treatment	Trait	BW (g)			BWG (g)		
		1 DOA	21 DOA	42 DOA	1-21 DOA	21-42 DOA	1-42 DOA
Heat conditioning (HC):							
	Non heat conditioning (NHC)	41.40±0.87	604.3 ^b ±60.43	1830.8 ^b ±138.30	562.9 ^b ±60.42	1225.1 ^b ±133.53	1788.6 ^b ±138.38
	Heat conditioning (HC)	41.26±1.05	620.4 ^a ±62.31	1908.3 ^a ±129.49	579.1 ^a ±62.45	1290.5 ^a ±128.41	1867.3 ^a ±129.53
	<i>Significance</i>	NS	*	*	*	*	*
Dietary supplements (T)							
	Control	41.41±0.87	587.1 ^b ±62.44	1799.9 ^b ±131.13	545.8 ^b ±62.35	1213.4 ^b ±132.59	1758.5 ^b ±131.07
	Vit. E+ Cr	41.37±0.91	610.8 ^a ±53.49	1886.9 ^a ±73.98	564.4 ^a ±53.66	1279.7 ^a ±87.20	1845.5 ^a ±74.07
	Vit. E+ Se	41.27±1.03	630.6 ^a ±63.24	1904.7 ^a ±170.87	589.3 ^a ±63.39	1273.2 ^a ±167.04	1863.5 ^a ±170.98
	Vit. E+Cr+Se	41.27±1.05	620.9 ^a ±60.39	1885.8 ^a ±141.87	579.6 ^a ±60.43	1264.9 ^a ±133.38	1844.4 ^a ±142.02
	<i>Significance</i>	NS	*	*	*	*	*
interaction							
A-Non heat conditioning (NHC) ×							
	Control	41.37±0.82	576.2 ^d ±55.81	1750.9 ^c ±138.77	534.8 ^d ±55.55	1175.9 ^c ±136.89	1709.5 ^c ±138.86
	Vit. E+ Cr	41.37±0.86	614.2 ^{abc} ±62.47	1849.8 ^b ±78.30	572.8 ^{abc} ±62.56	1240.4 ^{abc} ±85.98	1808.3 ^b ±78.44
	Vit. E+ Sel	41.37±1.01	631.4 ^{ab} ±57.38	1867.8 ^{ab} ±155.90	590 ^{ab} ±57.57	1231.0 ^{bc} ±146.40	1826.4 ^{ab} ±155.82
	Vit. E+Cr+Sel	41.48±0.82	595.4 ^{cd} ±54.11	1851.9 ^b ±142.09	553.9 ^{cd} ±54.08	1253 ^{abc} ±149.30	1810.4 ^b ±142.42
B- heat conditioning (HC) ×							
	Control	41.44±0.94	598.2 ^{bcd} ±67.61	1849 ^b ±103.95	556.7 ^{bcd} ±67.70	1250.8 ^{abc} ±119.21	1807.5 ^b ±103.76
	Vit. E+ Cr	41.37±0.97	607.3 ^{bcd} ±43.56	1924.9 ^{ab} ±46.48	565.9 ^{bcd} ±43.86	1319.0 ^a ±70.03	1882.6 ^{ab} ±46.53
	Vit. E+ Sel	41.17±1.07	629.8 ^{ab} ±69.64	1941.7 ^a ±180.06	588.6 ^{ab} ±69.74	1315.4 ^a ±178.29	1900.5 ^a ±180.26
	Vit. E+Cr+Sel	41.06±1.22	646.3 ^a ±56.17	1919.5 ^{ab} ±135.98	605.2 ^a ±56.11	1276.7 ^{ab} ±117.10	1878.4 ^{ab} ±135.87
	<i>Significance</i>	NS	*	*	*	*	*

^{a, b, c} Means± SD within a column with different superscripts are significantly different (P≤0.05).

NS = non-significant, * = P≤ 0.05.

Table (5). Effect of some dietary supplements and early age heat conditioning on feed intake (FI) and Feed conversion ratio (F.C) of broiler chicks at different ages.

Treatment	Trait	FI (g)			FC ratio		
		1-21DOA	21-42 DOA	1-42 DOA	1-21 DOA	21-42 DOA	1-42 DOA
Heat conditioning (HC):							
	Non heat conditioning (NHC)	798 ^b ±13.15	2538 ^b ±47.57	3336 ^b ±51.30	1.41±0.148	2.10 ^a ±0.236	1.88 ^a ±0.144
	Heat conditioning (HC)	809 ^a ±27.56	2565 ^a ±28.72	3374 ^a ±39.35	1.43±0.148	2.01 ^b ±0.199	1.81 ^b ±0.120
	<i>Significance</i>	*	*	*	NS	*	*
Dietary supplements (T)							
	Control	799 ^b ±28.73	2543 ^b ±38.28	3342 ^b ±55.05	1.48 ^a ±0.171	2.12 ^a ±0.240	1.91 ^a ±0.146
	Vit. E+ Cr	799 ^b ±18.02	2561 ^a ±42.51	3360 ^{ab} ±44.43	1.42 ^b ±0.137	2.01 ^b ±0.150	1.82 ^b ±0.077
	Vit. E+ Se	805 ^{ab} ±14.07	2560 ^a ±30.86	3365 ^a ±32.0	1.38 ^b ±0.135	2.04 ^{ab} ±0.258	1.82 ^b ±0.154
	Vit. E+Cr+Se	812 ^a ±23.13	2541 ^b ±49.20	3353 ^{ab} ±59.37	1.41 ^b ±0.132	2.03 ^b ±0.218	1.83 ^b ±0.133
	<i>Significance</i>	*	*	*	*	*	*
interaction							
A-Non heat conditioning (NHC) ×							
	Control	792 ^c ±8.05	2520 ^b ±35.18	3311 ^c ±40.34	1.50 ^a ±0.157	2.17 ^a ±0.260	1.95 ^a ±0.162
	Vit. E+ Cr	796 ^{bc} ±15.12	2558 ^a ±51.10	3354 ^b ±51.62	1.40 ^{bc} ±0.150	2.07 ^{abc} ±0.151	1.86 ^{bc} ±0.082
	Vit. E+ Se	806 ^b ±15.28	2551 ^a ±36.0	3358 ^{ab} ±40.16	1.38 ^c ±0.124	2.10 ^{ab} ±0.255	1.85 ^{bc} ±0.153
	Vit. E+Cr+Se	799 ^{bc} ±8.01	2523 ^b ±54.8	3323 ^c ±57.33	1.46 ^{abc} ±0.137	2.04 ^{abc} ±0.256	1.85 ^{bc} ±0.146
B- heat conditioning (HC) ×							
	Control	806 ^b ±38.88	2567 ^a ±24.07	3373 ^{ab} ±50.51	1.47 ^{ab} ±0.184	2.07 ^{abc} ±0.213	1.87 ^b ±0.118
	Vit. E+ Cr	803 ^{bc} ±20.20	2565 ^a ±32.42	3366 ^{ab} ±35.78	1.47 ^{ab} ±0.123	1.95 ^c ±0.124	1.79 ^c ±0.056
	Vit. E+ Se	803 ^{bc} ±12.80	2568 ^a ±21.96	3372 ^{ab} ±19.47	1.38 ^c ±0.147	1.98 ^{bc} ±0.252	1.79 ^c ±0.152
	Vit. E+Cr+Se	825 ^a ±26.58	2560 ^a ±35.17	3383 ^a ±44.87	1.37 ^c ±0.115	2.02 ^{bc} ±0.175	1.81 ^{bc} ±0.119
	<i>Significance</i>	*	*	*	*	*	*

^{a, b, c} Means± SD within a column with different superscripts are significantly different ($P \leq 0.05$).

NS = non-significant, * = $P \leq 0.05$.

Table (6). Effect of some dietary supplements and early age heat conditioning on hematological parameters of broiler chicks at 21 DOA.

Treatment	Trait (21 DOA)	Hb (g/100 ml)	Ht (%)	RBC'S (10 ⁶ /mm ³)	MCH (pg/dl)	MCHC (%)	MCV (μ m ³)	H/L ratio
Heat conditioning (HC):								
	Non heat conditioning (NHC)	8.79 ^b ±0.96	34.01 ^b ±0.75	3.01 ^b ±0.26	28.78±0.56	25.83 ^b ±2.48	105.03 ^b ±9.01	0.59 ^a ±0.026
	Heat conditioning (HC)	9.87 ^a ±0.58	35.76 ^a ±1.45	3.43 ^a ±0.087	29.18±1.61	27.59 ^a ±1.02	112.9 ^a ±4.75	0.51 ^b ±0.031
	<i>Significance</i>	*	*	*	NS	*	*	*
Dietary supplements (T)								
	Control	8.55 ^b ±0.49	34.05 ^b ±1.43	3.06 ^b ±0.13	27.91 ^b ±0.39	25.10 ^b ±0.92	111.30 ^{ab} ±4.08	0.57±0.049
	Vit. E+ Cr	8.73 ^b ±0.43	34.20 ^b ±1.45	3.03 ^b ±0.16	28.80 ^{ab} ±0.77	25.53 ^b ±0.78	112.86 ^a ±3.82	0.55±0.057
	Vit. E+ Se	9.96 ^a ±0.79	35.56 ^a ±0.88	3.37 ^a ±0.31	29.55 ^a ±1.30	28.00 ^a ±1.88	105.88 ^b ±8.04	0.54±0.044
	Vit. E+Cr+Se	10.08 ^a ±0.90	35.75 ^a ±1.33	3.41 ^a ±0.44	29.66 ^a ±1.36	28.20 ^a ±2.27	106.00 ^b ±12.7	0.54±0.044
	<i>Significance</i>	*	*	*	*	*	*	NS
interaction								
A-Non heat conditioning (NHC) ×								
	Control	8.20 ^d ±0.45	32.83 ^b ±0.64	2.97 ^{bc} ±0.120	27.60 ^c ±0.13	24.97 ^b ±1.39	110.55 ^a ±6.30	0.61 ^a ±0.040
	Vit. E+ Cr	8.40 ^{cd} ±0.15	32.90 ^b ±0.43	2.94 ^c ±0.025	28.52 ^{bc} ±0.35	25.53 ^b ±0.51	111.82 ^a ±0.95	0.59 ^a ±0.020
	Vit. E+ Se	9.26 ^b ±0.20	35.0 ^a ±0.11	3.10 ^{bc} ±0.040	29.93 ^{ab} ±0.81	26.49 ^b ±0.66	112.94 ^a ±0.86	0.58 ^{ab} ±0.030
	Vit. E+Cr+Se	9.30 ^b ±0.15	35.33 ^a ±1.25	3.03 ^{bc} ±0.081	30.67 ^a ±0.33	26.32 ^b ±1.36	116.65 ^a ±3.93	0.58 ^{ab} ±0.015
B- heat conditioning (HC) ×								
	Control	8.90 ^{bc} ±0.20	35.26 ^a ±0.55	3.15 ^b ±0.020	28.22 ^{bc} ±0.28	25.24 ^b ±0.35	112.05 ^a ±0.54	0.53 ^{bc} ±0.010
	Vit. E+ Cr	9.06 ^b ±0.34	35.50 ^a ±0.10	3.11 ^{bc} ±0.032	29.09 ^{abc} ±1.06	25.54 ^b ±1.12	113.90 ^a ±5.68	0.52 ^c ±0.064
	Vit. E+ Se	10.66 ^a ±0.25	36.13 ^a ±0.10	3.65 ^a ±0.100	29.17 ^{abc} ±1.77	29.52 ^a ±1.25	98.82 ^b ±3.39	0.51 ^c ±0.015
	Vit. E+Cr+Se	10.86 ^a ±0.43	36.16 ^a ±1.52	3.79 ^a ±0.152	28.64 ^{bc} ±1.19	30.07 ^a ±0.71	95.36 ^b ±6.99	0.50 ^c ±0.015
	<i>Significance</i>	*	*	*	*	*	*	*

^{a, b, c} Means± SD within a column with different superscripts are significantly different (P≤0.05).

NS = non-significant, * = P≤0.05.

Table (7). Effect of some dietary supplements and early age heat conditioning on hematological parameters of broiler chicks at 42 DOA.

Treatment	Trait (42 DOA)	Hb (g/100 ml)	Ht (%)	RBC'S (10 ⁶ /mm ³)	MCH (pg/dl)	MCHC (%)	MCV (μ m ³)	H/L ratio
Heat conditioning (HC):								
Non heat conditioning (NHC)		10.93 ^b ±0.46	29.90 ^b ±0.90	3.30 ^b ±0.27	31.77±2.32	36.54±1.43	90.56±5.27	0.61 ^a ±0.026
Heat conditioning (HC)		11.47 ^a ±0.56	31.60 ^a ±1.09	3.62 ^a ±0.10	33.10±1.27	36.32±1.05	87.47±1.77	0.53 ^b ±0.031
	<i>Significance</i>	*	*	*	NS	NS	NS	*
Dietary supplements (T)								
Control		10.73 ^b ±0.46	29.83 ^b ±0.90	3.32 ^b ±0.13	32.25±0.79	35.98±1.28	89.70±3.01	0.59±0.049
Vit. E+ Cr		10.80 ^b ±0.37	30.20 ^b ±1.45	3.36 ^{ab} ±0.16	32.08±0.63	35.78±0.95	89.66±1.16	0.57±0.057
Vit. E+ Se		11.55 ^a ±0.37	31.40 ^a ±0.88	3.58 ^a ±0.30	32.37±2.37	36.79±1.18	87.96±5.27	0.56±0.044
Vit. E+Cr+Se		11.73 ^a ±0.30	31.58 ^a ±1.20	3.57 ^a ±0.33	33.04±3.20	37.17±1.21	88.75±6.23	0.56±0.044
	<i>Significance</i>	*	*	*	NS	NS	NS	NS
interaction								
A-Non heat conditioning (NHC) ×								
Control		10.40 ^c ±0.37	29.06 ^c ±0.52	3.22 ^c ±0.120	32.23±0.72	35.77±1.85	90.08 ^{ab} ±4.59	0.63 ^a ±0.040
Vit. E+ Cr		10.50 ^c ±0.10	28.90 ^c ±0.43	3.22 ^c ±0.015	32.57±0.15	36.33±0.61	89.66 ^{ab} ±1.40	0.61 ^a ±0.021
Vit. E+ Se		11.30 ^b ±0.26	30.66 ^b ±0.11	3.31 ^c ±0.045	34.17±0.78	36.86±0.91	92.67 ^a ±0.78	0.60 ^{ab} ±0.031
Vit. E+Cr+Se		11.53 ^{ab} ±0.15	31.0 ^{ab} ±1.25	3.45 ^{bc} ±0.47	33.42±4.98	37.20±1.90	89.84 ^{ab} ±9.49	0.60 ^{ab} ±0.015
B- heat conditioning (HC) ×								
Control		11.06 ^b ±0.26	30.60 ^b ±0.15	3.43 ^{bc} ±0.021	32.27±1.02	36.18±0.72	89.32 ^{ab} ±1.05	0.55 ^{bc} ±0.010
Vit. E+ Cr		11.10 ^b ±0.26	31.50 ^{ab} ±0.10	3.51 ^{bc} ±0.032	31.59±0.52	35.24±1.01	89.66 ^{ab} ±1.18	0.54 ^c ±0.064
Vit. E+ Se		11.80 ^a ±0.30	32.13 ^a ±0.57	3.86 ^a ±1.0	30.57±1.93	36.72±1.63	83.25 ^b ±1.53	0.53 ^c ±0.015
Vit. E+Cr+Se		11.93 ^a ±0.31	32.16 ^a ±1.0	3.70 ^{ab} ±0.051	32.65±0.60	37.14±0.29	87.66 ^{ab} ±1.85	0.52 ^c ±0.015
	<i>Significance</i>	*	*	*	NS	NS	*	*

^{a, b, c} Means ± SD within a column with different superscripts are significantly different ($P \leq 0.05$).

NS = non-significant, * = $P \leq 0.05$.

Table (8) . Effect of some dietary supplements and early age heat conditioning on Carcass characteristics of broiler chicks at 42 day of age.

Treatment	Trait	Caracas (%)	Breast (%)	Thigh (%)	Liver (%)	Gizzard (%)
Heat conditioning (HC):						
	Non heat conditioning (NHC)	69.15 ^b ±2.21	16.91 ^b ±0.57	12.51 ^b ±0.44	2.15 ^a ±0.19	1.16 ^b ±0.06
	Heat conditioning (HC)	73.16 ^a ±1.15	17.67 ^a ±0.19	13.20 ^a ±0.39	2.10 ^b ±0.05	1.25 ^a ±0.07
	<i>Significance</i>	*	*	*	*	*
Dietary supplements (T)						
	Control	69.16 ^b ±3.47	16.76 ^b ±0.75	12.36 ^b ±0.53	2.31 ^a ±0.168	1.12 ^b ±0.044
	Vit. E+ Cr	71.38 ^a ±1.89	17.44 ^a ±0.48	12.84 ^a ±0.51	2.09 ^b ±0.030	1.22 ^a ±0.076
	Vit. E+ Se	72.50 ^a ±2.45	17.53 ^a ±0.42	13.14 ^a ±0.49	2.03 ^c ±0.028	1.25 ^a ±0.055
	Vit. E+Cr+Se	71.58 ^a ±2.01	17.44 ^a ±0.21	13.08 ^a ±0.26	2.07 ^{bc} ±0.034	1.24 ^a ±0.077
	<i>Significance</i>	*	*	*	*	*
interaction						
A-Non heat conditioning (NHC) ×						
	Control	66.23 ^d ±1.72	16.08 ^d ±0.080	11.89 ^d ±0.136	2.46 ^a ±0.050	1.09 ^d ±0.010
	Vit. E+ Cr	69.73 ^c ±0.55	17.09 ^c ±0.453	12.38 ^c ±0.064	2.09 ^c ±0.043	1.16 ^{cd} ±0.061
	Vit. E+ Sel	70.73 ^{bc} ±2.23	17.23 ^{bc} ±0.362	12.93 ^{ab} ±0.060	2.01 ^d ±0.005	1.21 ^{abc} ±0.015
	Vit. E+Cr+Sel	69.73 ^c ±0.79	17.26 ^{bc} ±0.052	12.85 ^{abc} ±0.051	2.06 ^{cd} ±0.043	1.18 ^{bc} ±0.070
B- heat conditioning (HC) ×						
	Control	72.10 ^{ab} ±1.17	17.45 ^{abc} ±0.132	12.83 ^{bc} ±0.230	2.16 ^b ±0.023	1.15 ^{cd} ±0.045
	Vit. E+ Cr	73.03 ^a ±0.72	17.79 ^a ±0.058	13.30 ^{ab} ±0.105	2.10 ^c ±0.015	1.27 ^{ab} ±0.050
	Vit. E+ Sel	74.26 ^a ±0.86	17.83 ^a ±0.198	13.35 ^a ±0.689	2.06 ^{cd} ±0.020	1.28 ^a ±0.065
	Vit. E+Cr+Sel	73.26 ^a ±1.01	17.62 ^{ab} ±0.101	13.31 ^{ab} ±0.095	2.08 ^c ±0.025	1.30 ^a ±0.020
	<i>Significance</i>	*	*	*	*	*

^{a, b, c} Means± SD within a column with different superscripts are significantly different ($P \leq 0.05$).

NS = non-significant, * = $P \leq 0.05$.

Table (9). Effect of some dietary supplements and early age heat conditioning on weights of some organs of broiler chicks at 42 day of age.

Treatment	Trait	Heart (%)	A.F (%)	Thymus (%)	Bersa (%)	Spleen (%)
Heat conditioning (HC):						
Non heat conditioning (NHC)		0.32 ^b ±0.04	1.12 ^b ±0.02	0.21 ^b ±0.02	0.12±0.008	0.22±0.007
Heat conditioning (HC)		0.35 ^a ±0.03	1.17 ^a ±0.03	0.23 ^a ±0.01	0.11±0.007	0.22±0.005
<i>Significance</i>		*	*	*	NS	NS
Dietary supplements (T)						
Control		0.30 ^c ±0.033	1.12±0.039	0.22±0.014	0.12±0.008	0.22±0.004
Vit. E+ Cr		0.34 ^b ±0.032	1.14±0.022	0.22±0.017	0.12±0.009	0.21±0.005
Vit. E+ Se		0.37 ^a ±0.012	1.15±0.039	0.23±0.014	0.11±0.005	0.21±0.007
Vit. E+Cr+Se		0.36 ^{ab} ±0.017	1.15±0.030	0.23±0.014	0.11±0.005	0.21±0.005
<i>Significance</i>		*	NS	NS	NS	NS
interaction						
A-Non heat conditioning (NHC) ×						
Control		0.28 ^c ±0.032	1.11 ^d ±0.026	0.21±0.010	0.12±0.005	0.22±0.005
Vit. E+ Cr		0.31 ^{bc} ±0.015	1.13 ^{cd} ±0.020	0.21±0.010	0.12±0.011	0.22±0.005
Vit. E+ Sel		0.36 ^a ±0.011	1.12 ^{cd} ±0.010	0.22±0.010	0.11±0.005	0.21±0.010
Vit. E+Cr+Sel		0.34 ^{ab} ±0.011	1.13 ^{cd} ±0.010	0.23±0.026	0.12±0.005	0.22±0.005
B- heat conditioning (HC) ×						
Control		0.31 ^{bc} ±0.035	1.14 ^{bcd} ±0.047	0.23±0.010	0.11±0.011	0.22±0.010
Vit. E+ Cr		0.36 ^a ±0.023	1.16 ^{abc} ±0.020	0.23±0.015	0.11±0.005	0.22±0.005
Vit. E+ Sel		0.38 ^a ±0.005	1.19 ^a ±0.010	0.24±0.015	0.11±0.005	0.21±0.005
Vit. E+Cr+Sel		0.37 ^a ±0.011	1.18 ^{ab} ±0.005	0.23±0.010	0.11±0.005	0.22±0.005
<i>Significance</i>		*	*	NS	NS	NS

^{a, b, c} Means± SD within a column with different superscripts are significantly different ($P \leq 0.05$).

NS = non-significant, * = $P \leq 0.05$.

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الاستجابات الفسيولوجية لدجاج التسمين المتأثره بالتهينة الحرارية في عمر مبكر واضافة بعض مضادات الاكسده الى العلائق

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استهدفت الدراسة محاولة تخفيف التأثيرات الضارة لارتفاع درجات الحرارة على الأداء الفسيولوجي لدجاج التسمين خلال فترة الانتاج وفيها تم استخدام عدد ٢٤٠ كتكوت تسمين من سلالة (كب) قسمت الى مجموعتين (تهينه حراريه في عمر مبكر، بدون تهينه حراريه) ثم قسمت كل مجموعه الى اربعة تحت مجموعات

- الاولى منها للمقارنه (الكنترول)
- الثانية تم اضافة فيتامين هـ (٢٠٠ وحده دوليه/كجم عليقه) + الكروم العضوي (٠.٨ ملجم/كجم عليقه)
- الثالثه فيتامين هـ (٢٠٠ وحده دوليه/كجم عليقه) + السيلينيوم العضوي (٠.٣ ملجم/كجم عليقه)
- الرابعه فيتامين هـ (٢٠٠ وحده دوليه/كجم عليقه) + الكروم العضوي (٠.٨ ملجم/كجم عليقه) + السيلينيوم العضوي (٠.٣ ملجم/كجم عليقه).

في اليوم الخامس من العمر تم تعريض المجموعه الاولى من الكتاكيت الى تهينه حراريه في عمر مبكر (٤٠م ± ١ لمدة ٢٤ ساعه) بينما تركت الثانيه بدون معاملة حراريه ثم تربية الكتاكيت في بطاريات مناسبة مع تقديم كافة اساليب الرعاية المتكامله، في اليوم ٤٢ من العمر تم تعريض كل الطيور الى درجة حراره مرتفعه (٤١م^٥ لمدة ساعه). وكانت أهم النتائج المتحصل عليها كما يلي:-

١. مجموعات الطيور المعرضه للتهينه الحراريه في عمر مبكر سجلت ارتفاع معنوي في وزن الجسم ومعدل الزيادة الوزنيه وكذلك ايضا مجموعات المعاملات الغذائيه والتداخل بين عاملي الدراسه (التهيه الحراريه، المعاملات الغذائيه).
٢. الطيور المعرضه للتهينه الحراريه سجلت تحسن معنوي في معدلات استهلاك العلف وكفاءة تحويل الغذاء للفترات العمريه ١- ٢١ ، ٢١-٤٢ و ٤٢-٤٢١ يوم في العمر وكذلك مجموعات المعاملات الغذائيه والتداخل بين عاملي الدراسه (التهيه الحراريه، المعاملات الغذائيه).
٣. وجد تحسن معنوي في بعض قياسات الدم المدروسه وكذلك نسبة كرات الدم البيضاء الليمفاويه إلى المتعادلة لصالح مجموعات الطيور المهينه حراريا في عمر مبكر وكذلك مجموعات الطيور في المعاملات الغذائيه والتداخل بين عاملي الدراسه (التهيه الحراريه، المعاملات الغذائيه).