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BREED DIFFERENCES AND PHENOTYPIC CORRELATIONS OF ANTIOXIDANT ENZYMES ACTIVITIES, SOME PHYSIOLOGICAL PARAMETERS AND PRODUCTIVE TRAITS OF CHICKEN

2. PHENOTYPIC CORRELATIONS

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Abstract*:* *The objectives of the study were to estimate the correlation coefficients among antioxidant enzymes activities [glutathione peroxidase (GPX), superoxide dismutase (SOD) and catalase (CAT)] of red blood cells haemolycate, some physiological and haematological parameters [hemoglobin (Hb), haematocrit (Ht), red blood cells count (RBCs), lymphocyte (LYMP), basophil (BASO), eosinophil (ESINO) and neutrophils (STAFF and SEGMENT) and some productive performance [body weight (BW), egg weight (EW), egg shape index (SI) yolk (Y%), albumen (Alb%), and shell (Sh%), yolk index (YI), Haugh units (HU), shell thickness (ST), yolk color (YC), egg specific gravity (ESG), shell weight per unit surface area (SWUSA), egg surface area (ESA), egg shell volume (ESV), shell density (SD)] in different chicken breeds (Fayoumi (Fay), Dandarawi (Dan), Sinai (Sin) as local breeds compare to White Leghorn (WL) as a hybrid foreign breed for egg production) under prevailing conditions of Egypt. Blood samples were collected at the period of the highest egg production (HEP) 38 weeks of age.*

The main results were as follows*: There were significant differences among breeds in antioxidant enzymes activities, some haematological parameters and production traits. Considerable variations of the correlation values among antioxidant enzymes activities, some physiological parameters and productive traits of different chicken breeds were found. BW was significantly (P≤0.01) and positively correlated with Hb, Ht and RBCs for all breeds. SEGMENT cells showed a significant positive correlation with BW for all breeds except Dan. STAFF cell showed a significant positive correlation with BW for Fay breed, while it was not significant for WL, Dan and Sin. Sinai breed showed superior estimates of correlation between BW and each of antioxidant enzymes activities. CAT and SOD enzymes showed a significant positive correlation with BW for*

WL, Dan and Sin, while it was insignificant for Fay breed. Correlations between antioxidant enzymes activities and other blood parameters had considerable values and varied among breeds. The Hb, Ht, RBCs, LYMP, BASO, ESINO and neutrophils cells are correlated with each other with high and significant values and varied according to the breed. Significant ($P \leq 0.01$) positive correlations were found between each of two antioxidant GPX, CAT and SOD activities for all breeds. Considerable variations of the correlations values among breeds were found among egg weight and egg quality traits as well. Antioxidant enzymes activities, blood haematological parameters, EW and egg quality traits were correlated with high and significant values. It could be concluded that previous blood parameters can be done as prediction indicators to increase and improve egg production and can be also used in selection programs to improve egg production traits of chickens and this has the advantages of saving time and efforts. Also, the highly correlation values obtain in our study may be attributed to the pleiotropic effects and consequently performing selection in any of the two traits may lead to an improvement in the other trait. This finding indicates that these parameters are useful and important with potential use in breeding programs as early predictors for indirect selection or crosses which associated with disease resistance, highly tolerance to oxidative stress and performance traits.

INTRODUCTION

The science of genetics and physiology provide the basic knowledge required creating efficient genetic change in production and health traits and, therefore, these disciplines are key components in developing improved breeding programs. The physiological and haematological parameters are good indicator to predict and estimate productive and reproductive performance in chickens **(Emmerson, 2003)**. Endogenous enzymatic antioxidants like catalase, superoxide dismutase and glutathione peroxidase play vital roles in scavenging oxidative radicals and are considered as markers for evaluation of oxidative stress. Damage due to free radicals lead to cellular injury, cancer, aging, atherosclerosis, other pathological disorders and dysfunctions in some organs. Antioxidants play important roles in maintaining the health, productivity and reproductive characteristics of the animals **(Spurlock and Savage, 1993)**. There are some observations about the correlation of antioxidant enzymes activities and production traits, body weight, weight gain and growth rate **(LaVronga and Combs, 1982; Mézes *et al.*, 1994; Farahat *et al.*, 2008 a; b)**. The productivity and quality of breeding eggs have an overall significance on the continuity of flocks and economical breeding **(Sogut *et al.*, 2001)**. Egg production depends on many characters such as body weight, egg weight, shell thickness, egg specific gravity and others **(Muir, 1990; Brah *et al*., 1992)** which influence egg production independently and/or associated with each other. Commercial poultry breeding has amongst its objectives, the improvement of production potential and disease resistance. Over the years there has been much emphasis on growth improvement that is negatively associated with some aspects of immunological performance of poultry as reported by **Yunis *et al*. (2000) and Cheema *et al*. (2003)**. Existence of any significant relationship between blood biochemical features such as antioxidant enzymes activities and some haematological parameters with performance may help to identify a suitable breeding program.

Information on phenotypic and genetic parameters for production traits and traits related to health are needed for the design of breeding programs aimed to improving the balance between production and health traits. The present research was conducted to estimate the correlation coefficients among antioxidant enzymes activities [glutathione peroxidase (GPX), superoxide dismutase (SOD), and catalase (CAT)] of red blood cells haemolycate, some physiological and haematological parameters [hemoglobin (Hb), haematocrit (Ht), red blood cells count (RBCs), lymphocyte (LYMP), basophil (BASO), eosinophil (ESINO) and neutrophils (STAFF and SEGMENT) and some productive performance [body weight (BW), egg weight (EW), egg shape index (SI) yolk (Y%), albumen (Alb%), and shell (Sh%), yolk index (YI), Haugh units (HU), shell thickness (ST), yolk color (YC), egg specific gravity (ESG), shell weight per unit surface area (SWUSA), egg surface area (ESA), egg shell volume (ESV), shell density (SD)] in four chicken breeds (Fayoumi (Fay), Dandarawi (Dan), Sinai (Sin) as local breeds compare to White Leghorn (WL) as a hybrid foreign breed for egg production) under prevailing conditions of Egypt at the period of the highest egg production (HEP) 38 weeks of age.

MATERIALS AND METHODS

Birds, diet and management:

This experiment was carried out at El Takamoly Poultry Project, Fayoum, Egypt. Chemical analyses were performed in the laboratories of the Poultry Department, Faculty of Agriculture, Fayoum University**.** Four chicken breeds: Dandarawi (Dan), Fayoumi (Fa), Sinai (Sin) and White Leghorn (WL) were used in this study. All birds were clinically healthy and reared under the same environmental, managerial and hygienic condition.

The birds of different breeds fed the same diets. The minerals and vitamins were adequately supplied to cover the requirements according to the **Egyptian Ministerial Decree No. 1498 (1996)**.

Physiological parameters:

A total number of 120 blood samples were collected from brachial vein (30 ♀ of each breed) at the period of the highest egg production (HEP) 38 weeks of age to determine the antioxidant enzymes activities, Hemoglobin (Hb), haematocrit (Ht), red blood cells (RBCs) count, lymphocyte (LYMP), basophil (BASO), eosinophil (ESINO), neutrophils (STAFF and SEGMENT) by using ABX. Cell counter by Mieros 18. Antioxidant enzymes activities (CAT, SOD and GPX) were determined, in red blood cells haemolycate by enzymatic methods using available commercial kits (SCLAVO INC., 5 Mansard Count, Wayne NJ 07470, USA).

Production traits:

Body weight (BWg) was measured at the same time as the blood samples were obtained. Egg weight (EWg) was recorded for each breed from the age at first egg till 52 weeks of age.

Egg quality traits:

Thirty eggs were taken from each breed at 38 weeks of age to evaluate exterior and interior egg quality according to **Stino *et al.* (1982)**. Egg shape index (SI) was estimated as the maximum width to its length. Eggs were individually weighed, then broken and the inner contents were placed on a leveled glass surface to determine yolk and albumen grade. Percentages of yolk, albumen and shell were calculated. Yolk index (YI) was calculated as the ratio of yolk height to its diameter. Haugh unit (HU) scores were calculated according to **Haugh (1937)**. Shell thickness (ST) was measured by Ames shell thickness gauge to the nearest mm. Yolk color (YC) scores were determined using Roche fan. Egg specific gravity (ESG) was calculated by **Harms *et al.* (1990)**. Egg surface area (ESA) was calculated according to **Paganel *et al.* (1974)**. Shell weight per unit surface area (SWUSA) = shell weight, mg/ESAcm^2. Egg shell volume (ESV) was calculated according to **Rahn (1981)** and shell density (SD) was estimated according **to Nordstrom and Qusterhant (1982)**.

Statistical analysis:

Data were subjected to a one-way analysis of variance with breed effect, the statistical model used was as follows; $\mathbf{Y_{ij} = \mu + G_i + e_{ij}}$, Where; $\boldsymbol{\mu}$

= Overall mean, $\mathbf{G_i}$ = breed effect, $\mathbf{e_{ij}}$ = experimental error, using the General Linear Model (GLM) procedure of SPSS User's Guide, **(SPSS, 1999)**. Means were compared for breed effect by Duncan's new multiple range test **(Duncan's, 1955)** when significant F values were obtained ($P<0.05$). Correlation analyses were performed using the procedure CORR.

RESULTS AND DISCUSSION

Phenotypic variations of antioxidant enzymes activities:

The phenotypic variations of antioxidant enzymes activities in different breeds showed that WL breed had significantly highest while; Fay had the lowest GPX, CAT and SOD activities (1126.94, 788.86 and 986.07 vs. 1000.59, 700.41 and 875.52, respectively). However, Sin and Dan were intermediated as shown in Table 1. These results appear to support those of **Mizuno (1984) and Farahat *et al.*, (2008a and b)** which found breed differs in the activity of antioxidant enzymes in chicken.

Phenotypic variations of haematological parameters:

Results of some physiological and haematological parameters for the different breeds are presented in Table 1. No significantly differences among WL, Dan, Fay and Sin chicken were found for both of Hb and Ht values, however, Fay were insignificantly highest and Dan lowest values (Table 1). In contrary, **El-Menshawy (2003)** found that blood Hb content of different strains was significantly different. The higher level of Ht may have enhanced oxygen delivery to the tissue. Also, this increment is supposed to be a factor for increased blood volume as a reaction to increase body oxygen requirement. The RBCs results showed that, Dan had the significant lowest values and no significantly differences were found among WL, Fay and Sin breeds (Table 1). Dan had the highest LYMP% (52.75), while Sin had the lowest (46.50). ESINO play a major phagocytes role in the defense against parasitic organism **(Glick *et al.*, 1964)**. There were no significant differences due to the breed effect for ESINO and BASO% as shown in Table 1. Similar trend was reported by **El-Safty *et al.* (2006)** for ESINO cells between two genotypes of chickens. White blood cells reacting with Lymphokines to increase their ability to battle the foreign invasion, significant differences were found among breeds for SEGMENT cells count, WL had the highest value and Dan had the lowest (48.92vs. 42.42). Also, breed had significant effect on STAFF cells; Fay had the highest values, while Sin had the lowest (Table 1).

Phenotypic variations of body weight (BW):

Phenotypic variations of BW in different breeds at 38 weeks of age are given in Table 2. Significant differences were found among the breeds showing the highest average BW in WL, while the lowest in Sin breed (1920.83 vs. 1441.67 g) and insignificant differences were found between Dan and Fay breed (1712.50 vs. 1629.67 g). Genetic background of the breed or strain is considered as an important factor in controlling its body weight. Consequently, variations in body weight among and within breeds or strains at the same age have been observed in the literature **(Habeb, 2007; El-Anwer *et al.*, 2009)**.

Egg production traits:

Results of egg characteristics for the different breeds are given in Table 2. WL pullets produced the heaviest eggs, whereas Dan chickens produced the lightest eggs and Sin had intermediate values (Table 2). The performance of egg weight for Dan, Fay and Sin breeds in the present study are similar to those reported by **El-Full *et al.* (2005) and Zaki (2006). Metwally (2006)** reported heavier egg weight for Dandarawi (40.70 to 44.08g) whereas lower estimates of egg weight (36.1) was reported by **El-Afifi *et al.* (2008)**.

Results presented in Table 2 showed that breed significantly affected egg quality traits. It could be seen that Sin had significantly highest albumen% as compared to other breeds, whereas Fay had the lowest albumen% and a highest yolk% as compared to other breeds. No breed-related differences in the yolk% were found among Dan, Sin and WL. Eggs which were produced by WL and Dan had significantly highest shell weight% whereas eggs produced by Sin had the smallest shell weight%. Fayoumi showed significantly highest scores for YC than other breeds, while WL had the lowest and Sin and Dan had intermediate values (Table 2). Similar trend was reported by **El-Full *et al.* (2005)** for this trait concerning Fay, Dan and Sin breeds. No breed-related differences in the yolk index and HU were found among Dan, Sin and WL, however eggs produced from Fay had significant lowest yolk index and HU. Similar trend was reported by **El-Labban (2000) and El-Full *et al.* (2005)**, while lower values for WL and Fay were found by **Zaki (2006)**. Dan and Fay had higher shape index than Sin which characterized by lower estimates indicating that Sin as a developed strains produce eggs that tend to be less elongated compared to other breeds. On the contrary, **Ezzeldin and El-Labban (1989)** reported that local strains produce eggs that tend to be less elongated compared to crossbred strains. From Table 2, it is clear that Fay had significantly thicker shells and Sin had the lowest. **Ezzeldin and El-Labban (1989) and El-Full *et al.* (2005)** reported the same trend that egg shells of local strains were thicker than in crossbred eggs. On the contrary, **Rasmy (1984) and Zaki (2006)** reported insignificant breed differences in shell thickness and shell index. Egg specific gravity has been recommended as an accurate indicator of shell strength **(Well's, 1968)**. Despite being an indirect measure, it correlates well with direct methods but is non-destructive and has the practical advantage of speed and simplicity. It has also been shown to be an accurate predictor of shell thickness, much more reliable for this purpose than percentage shell **(Tyler and Geake, 1961)**. Eggs were produced by Sin hens had significantly lowest specific gravity comparably with those produced from both Dan and WL, while Fay breed was intermediate. Concerning shell density, the present result showed that there was no significant difference among breeds. Shell weight per unit surface area of WL genotype was significantly higher than that of Dan, Sin and Fay. In accordance to egg shell area, it could be observed that the ESA of WL and Sin breed was significantly higher than that of Fay and Dan. The eggs produced from WL recorded significantly highest egg shell volume compared to produce from Sin and Dan. Similar trend of genotype differences for internal egg quality and egg shell quality traits was reported by **El-Safty *et al.* (2006) and Zein El-Dein *et al.* (2009)**.

Correlation coefficients among body weight (BW), some blood parameters and antioxidant enzymes activities:

Correlation coefficients among (BW), some blood parameters and antioxidant enzymes activities for each breed separately are presented in Tables 3 and 4 Considerable variations of the correlations values among breeds were found. Similar trend of genotype differences for correlation coefficients among some blood parameters were reported by **El-Safty *et al.* (2006)**. BW was significantly ($P \leq 0.01$) and positively correlated with Hb, Ht and RBCs for all breeds (Tables 3 and 4). BW was significantly negatively correlated with LYMP for all breeds except Dan. SEGMENT cells showed a significantly positive correlation with BW for all breeds except Dan (Tables 3 and 4). STAFF cell showed a significantly positive correlation with BW for Fay breed, while it was insignificant for WL, Dan and Sin (0.54; $P \leq 0.01$, 0.10, 0.01 and 0.14, respectively). Correlation between BW and ESINO cells had a small magnitude and contradictory direction for WL, Sin, Dan and Fay breed (-0.03, -0.16, 0.23 and 0.01, respectively). The same trend was found for the correlation between BW and BASO cells (Tables 3 and 4).

Sinai showed superior estimates of correlation between BW and each of antioxidant enzymes activities (GPX, CAT and SOD) as shown in Tabes 3 and 4. Significant positive correlation was found between GPX enzyme activity with BW for Sin breed, while it was not significant for WL, Dan and Fay (0.40; P≤0.05, 0.24, 0.25 and 0.24, respectively). CAT and SOD showed a significant positive correlation with BW for WL, Dan and Sin, while it was insignificant for Fay breed (Tables 3 and 4). On the contrary, **LaVronga and Combs (1982) in chicken, Mézes *et al*. (1994) and Virág *et al*. (1996) in rabbit and also Farahat *et al.*, (2008 a and b)** in chicken reported negative correlations between production traits and GSHPx activity in BP, RBC and liver. The significant negative correlation between production traits and GSHPx activity in BP, RBC and liver in their studies may represent an adaptation mechanism to relatively low selenium intake particularly in animals with high growth rate also, the breeds, age and sex used in their study different from our study.

Antioxidant enzymes activities (GPX, CAT and SOD) showed a significant positive correlations (P≤0.01) with Hb, Ht, RBCS and SEGMENT whereas significant negative correlations (P≤0.01) with LYMP were found for all breeds. Also, correlations between antioxidant enzymes activities and other blood parameters had considerable values and varied among breeds as shown in Tables 3 and 4.

Correlation coefficients among the levels of Hb, Ht, RBCs, LYMP, BASO, ESINO and neutrophil (STAFF and SEGMENT) cells are presented in Tables 3 and 4. It could be concluded that most of these parameter are correlated with each other with high and significant values and varied acording to the breed. Also, significant (P≤0.01) positive correlations were found between each of two antioxidant GPX, CAT and SOD activities for all breeds as shown in Tables 3 and 4. Correlation among previous blood parameters and antioxidant enzymes activities (GPX, CAT and SOD) are not reported before, our results indicated that, estimate of one of these parameters and the measure of one antioxidant enzyme activity could be used as a good indicator to the other parameters and the other two enzymes activities based on the high correlation values which obtained in our results. Also, this highly correlation values may be attributed to the pleiotropic effects and consequently performing selection in any of the two traits may lead to an improvement in the other trait, but further research is needed to prove that hypothesis.

Correlation coefficients among some egg production and quality traits:

Considerable variations of the correlations values among breeds were found among egg weight and egg quality traits as shown in Tables 5 and 6. The same trend was reported by **El-Safty *et al.* (2006)** that, the correlations values among egg production traits depend on the genotype. Egg weight had significantly positive correlation with each of Alb% (0.65; $P \leq 0.01$), Y% (0.67; $P \leq 0.01$), ESA (0.99; $P \leq 0.01$) and ESV (0.75; $P \leq 0.01$) for WL breed. Egg weight was significantly positive correlated with each of SD (0.45; $P \leq 0.05$), SWUSA (0.48; $P \leq 0.01$), ESA (0.99; $P \leq 0.01$) and ESV (0.87; $P \leq 0.01$) and negatively correlated with HU (-0.45; $P \leq 0.05$) for Dan breed. Egg weight were significantly positive correlated with each of ESA (0.99; $P \leq 0.01$) and ESV in both Sin (0.75; $P \leq 0.01$) and Fay (0.38; $P \leq 0.05$) breeds while, it was significantly positively correlated with Alb% (0.43; $P \leq 0.05$), and negatively correlated with Y% (-0.43; $P \leq 0.05$) and HU (-0.41; $P \leq 0.05$) for Fay breed.

It was clear that significant and high negative correlations were found between Alb% and both Y% and Sh% in all breeds as shown in Tables 5 and 6. Alb% showed significant positive correlation with ESA and ESV for WL breed while, these values were insignificant for all breeds except the correlation between Alb% and ESA (-0.43; $P \leq 0.05$) for Fay breed (Tables 5 and 6). Yolk% seemed to be significantly and negatively correlated with each of ESA and ESV in WL and Fay breeds, while, these values were insignificant for Dan and Sin breeds (Tables 5 and 6). Y% were positively correlated with each of Sh%, ESG, SD and SWUSA and negatively correlated with HU for Dan breed. Significant negative correlations were found between Y% withYI (-0.36; $P \leq 0.05$) and HU (-0.44; $P \leq 0.05$) for Sin breed. The correlation coefficients of Sh% with each of ST, ESG, SD and SWUSA were significantly positive in all breeds; similar trend was reported by **El-Safty *et al.* (2006)**. Also, significant correlation with YI, SI for Fay layers, while the correlations between Sh% and HU were negative (-0.39; $P \leq 0.05$) for Dan and (-0.50; $P \leq 0.01$) for Sin layers. Yolk index had significantly positive correlation with HU (0.37; $P \leq 0.01$) for WL and (0.39; $P \leq 0.05$) for Dan layers, while the correlation between YI and HU was insignificant (0.31 and 0.18) for Sin and Fay layers. The correlation coefficient between YI with each of ESG (0.43; $P \leq 0.05$), SD (0.43; $P \leq 0.05$), and SWUSA (0.42; $P \leq 0.05$) were significantly positive for Fay layers. The correlation between Haugh units with each of ESG, SD, SWUSA, ESA and ESV were significantly negative for Dan, Sin and Fay layers while these values were insignificant for WL layers as shown in Tables 5 and 6. Shell index had significantly positive correlation with each of ST (0.51; $P \leq 0.01$), ESG (0.49; $P \leq 0.01$), SD (0.41; $P \leq 0.05$) and SWUSA (0.40; $P \leq 0.05$) for Fay breed. While these values were insignificant for other breeds. Shell thickness had significantly positive correlation with each of ESG, SD, SWUSA, and ESV for WL, Dan, Sin and Fay layers as shown in Tables 5 and 6. The correlation coefficient between ESG and each of SD and SWUSA was significantly positive for WL, Dan, Sin and Fay layers. Correlation of SD with SWUSA was significantly ($P \leq 0.05$) positive for WL, Dan, Sin and Fay layers. The correlation of ESA with ESV was significantly ($P \leq 0.05$) positive for all breeds as shown in Tables 5 and 6.

Correlation coefficients among some blood parameters, antioxidant enzymes activities, egg weight (EW) and egg quality traits regardless of the chicken breed:

The correlations estimates between the EW with each of Hb, Ht, RBCs count, SEGMENT and GPX, CAT and SOD antioxidant enzymes activities were significantly positive. While, the estimates with each of LYMP, STAFF and ESINO cells had a significantly negative values (Table 7). Correlation among Alb% and each of Hb, Ht and STAFF cells were negative and significant ($P \leq 0.01$). Concerning, the correlations among yolk% and each of Hb, Ht, RBCs count and STAFF cells were positive and significant, while, they were negatively and significant ($P \leq 0.05$) with each of GPX, CAT and SOD activities as shown in Table 7. There were positively and slightly high correlations of yolk color with Hb, Ht and STAFF cells (0.25, 0.25 and 0.39; $P \leq 0.01$, respectively), while, they were negatively and significant with each of GPX, CAT and SOD activities (-0.44, -0.42 and -0.43; $P \leq 0.01$, respectively). Likewise, there were significantly negative correlations between yolk index and each of Hb (-0.29; $P \leq 0.01$), Ht (-0.29; $P \leq 0.01$), RBCs (-0.20; $P \leq 0.05$) and STAFF (-0.24; $P \leq 0.01$). Significant negative correlations were found between HU and each of Hb (-0.25; $P \leq 0.01$), Ht (-0.29; $P \leq 0.01$) and STAFF cells (-0.37; $P \leq 0.01$), while it was significantly positive with each of GPX, CAT and SOD activities (0.24, 0.25 and 0.24; $P \leq 0.01$, respectively). Concerning shell quality traits, the relationships among blood parameters and antioxidant enzymes activity with SI had low values as shown in Table 7. Shell thickness was significantly positively correlated with each of Hb, Ht and STAFF cells (0.20, 0.23; $P \leq 0.05$ and 0.40; $P \leq 0.01$, respectively). Likewise, there were significant positive correlations between SD and each of GPX, CAT and SOD activities as shown in Table 7. Significant positive correlations were found between shell weight per unit surface area and each of Ht, GPX, CAT and SOD activities, whereas, it was significantly negative correlated with LYMP cells. Egg surface area and egg shell volume were significantly positively correlated with each of Hb, Ht, RBCs, SEGMENT cells count and GPX, CAT and SOD activities, whereas, they were significantly negative correlated with each of LYMP, STAFF and ESINO cells as shown in Table 7.

From the current results, it could be concluded that previous blood constituents can be done as prediction indicators to increase and improve egg production and can be also used in selection programs to improve egg production traits of chickens. Also, the highly correlation values obtained may be attributed to the pleiotropic effects and consequently performing selection in any of the two traits may lead to an improvement in the other trait. This finding indicates that these parameters are useful and important with potential use in breeding programs as early predictors for indirect selection or crosses which associated with disease resistance, highly tolerance to oxidative stress and performance traits.

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antioxidant enzymes, blood haematological, correlations.

Table 1. Antioxidant enzymes activities and some haematological parameters for different breeds at 38 weeks of age (Means ± SE).

Breed	Leghorn	Dandarawi	Fayoumi	Sinai
Antioxidant enzymes activities (unit/liter) in red blood cells haemolycate				
GPX	1126.94±19.32[a]	1001.47±14.05[b]	1000.59±30.14[b]	1041.37±24.68[b]
CAT	788.86±13.52[a]	701.03±9.80[b]	700.41±21.10[b]	728.96±17.28[b]
SOD	986.07±16.90[a]	876.28±12.30[b]	875.52±26.37[b]	911.20±21.59[b]
Haematological parameters				
Hb g/dl	12.43±0.09[a]	12.13±0.09[a]	12.52±0.09[a]	12.28±0.08[a]
Ht%	40.28±0.13[a]	39.40±0.28[a]	40.55±0.13[a]	39.85±0.25[a]
RBCs10^6/mm^3	3.02±0.02[a]	2.89±0.02[b]	3.03±0.01[a]	3.01±0.03[a]
LYMP%	46.50± 1.37[b]	52.75± 0.48[a]	48.83± 1.07[b]	48.75± 0 .83[b]
ESINO%	2.00±0.01[a]	2.08±0.01[a]	2.00±0.01[a]	2.00±0.01[a]
BASO%	0.08±0.08[a]	0.08±0.08[a]	0.08±0.08[a]	0.08±0.08[a]
SEGMENT %	48.92±1.35[a]	42.42±0.66[b]	46.00±1.10[a]	47.00±1.89[a]
STAFF%	2.50±0.26[ab]	2.66±0.26[ab]	3.08±0.23[a]	2.17±0.30[b]

[a,b,c] :Means within the same raw had different superscripts are significantly different ($P \leq 0.05$). GPX: glutathione peroxidase, CAT: catalase and SOD: superoxide dismutase, Hb: hemoglobin, HT: haematocrit, RBCs: red blood cells haemolycate, LYMP: lymphocytes, SEGMENT and STAFF: neutrophils, ESINO: eosinophils cells and BASO: basophils cells.

Table 2. Body weight (BW g), egg weight (EW g), egg components%, interior and exterior egg quality for different breeds at 38 weeks of age (Means ± SE).

Breed	Leghorn	Dandarawi	Fayoumi	Sinai
BW	1920.83±86.26[a]	1712.50±59.07[b]	1629.67±41.98[b]	1441.67±50.69[c]
EW	50.7±0.83[a]	42.4±0.89[c]	44.4±0.61[c]	48.5±0.71[b]
Alb%	57.89±0.45[a]	58.39±0.61[a]	54.84±0.49[b]	59.43±0.87[a]
Y%	29.76±0.38[b]	29.58±0.48[b]	33.43±0.27[a]	29.47±0.66[b]
Sh%	12.35±0.19[a]	12.03±0.21[a]	11.74±2.02[ab]	11.10±0.38[b]
YC	6.03±0.25[c]	6.70±0.25[b]	8.23±0.11[a]	6.93±0.19[b]
YI	43.03±0.58[ab]	44.05±0.64[a]	41.60±0.58[b]	43.83±0.52[a]
HU	77.07±1.14[a]	75.35±2.15[a]	66.65±1.78[b]	76.74±1.60[a]
SI	76.13±0.58[a]	76.81±2.51[a]	77.43±0.51[a]	75.75±0.48[a]
ST	37.10±0.41[ab]	37.47±0.38[ab]	38.97±0.69[a]	35.86±0.35[b]
ESG	1.102 ±0.001[a]	1.100±0.001[a]	1.099±0.001[ab]	1.095±0.002[b]
SD	0.098±0.001[a]	0.091±0.002[a]	0.091±0.002[a]	0.087±0.003[a]
SWUSA	0.096±0.001[a]	0.088±0.002[b]	0.087±0.002[b]	0.085±0.003[b]
ESA	64.98±0.71[a]	57.73±0.80[b]	59.60±0.54[b]	63.12±0.62[a]
ESV	24.12±0.42[a]	21.65±0.41[c]	23.21±0.44[ab]	22.64±0.34[bc]

[a,b,c] :Means within the same raw had different superscripts are significantly different ($P \leq 0.05$). EW: Egg weight, Alb%: Albumen%, Y%: Yolk%, Sh%: Shell weight%, YC: Yolk Color, YI: Yolk index, HU: Haugh units, SI: Shape index, ST: Shell thickness. ESG: Egg specific gravity, SD: Shell density, SWUSA: Shell weight per unit surface area, ESA: Egg surface area and ESV: Egg shell volume.

antioxidant enzymes, blood haematological, correlations.

Table 3. Correlation coefficients among body weight (BW), some blood parameters and antioxidant enzymes activities for Leghorn (above diagonal) and Dandarawi (below diagonal) breeds.

	BW	Hb	Ht	RBCs	LYMP	SEGMENT	STAFF	ESINO	BASO	GPX	CAT	SOD
BW		0.60**	0.55**	0.62**	-0.55**	0.54**	0.10	-0.03	-0.06	0.24	0.33*	0.33*
Hb	0.61**		0.91**	0.90**	-0.55**	0.55**	0.18	-0.20	-0.07	0.55**	0.63**	0.63**
Ht	0.43**	0.74**		0.92**	-0.56**	0.55**	0.18	-0.10	0.01	0.65**	0.72**	0.72**
RBCs	0.53**	0.93**	0.76**		-0.60**	0.59**	0.15	-0.14	0.08	0.61**	0.68**	0.68**
LYMP	0.02	-0.18	-0.33	-0.09		-0.99**	0.08	0.20	-0.07	-0.55**	-0.60**	-0.60**
SEGMENT	0.11	0.16	0.36*	0.10	-0.97**		-0.13	-0.25	-0.17	0.53**	0.59**	0.59**
STAFF	0.01	0.09	0.11	-0.01	-0.37*	0.20		-0.13	0.17	0.21	0.23	0.23
ESINO	0.23	-0.04	0.01	-0.13	-0.08	-0.08	0.39*		0.04	-0.33*	-0.33*	-0.33*
BASO	0.22	-0.03	-0.20	-0.01	0.16	-0.21	0.02	-0.01		0.02	0.02	0.02
GPX	0.25	0.40*	0.38*	0.36*	-0.60**	0.59**	0.23	-0.18	-0.11		0.98**	0.98**
CAT	0.36*	0.62**	0.43**	0.51**	-0.61**	0.58**	0.23	-0.14	0.01	0.90**		0.99**
SOD	0.36*	0.62**	0.43**	0.51**	-0.61**	0.58**	0.23	-0.14	0.01	0.90**	0.99**	

Hb: heamoglobiun, Ht: haematocrit, RBCs: red blood cells heamolycte, LYMP: lymphocytes, SEGMENT and STAFF: neutrophils, ESINO: eosinophils, BASO: basophils, GPX: glutathione peroxidase, CAT: catalase and SOD: superoxide dismutase.

** Correlation is significant at $P \leq 0.01$ level.

* Correlation is significant at $P \leq 0.05$ level.

Table 4. Correlation coefficients among body weight (BW), some blood parameters and antioxidant enzymes activities for Sinai (above diagonal) and Fayoumi (below diagonal) breeds.

	BW	Hb	Ht	RBCs	LYMP	SEGMENT	STAFF	ESINO	BASO	GPX	CAT	SOD
BW		0.53**	0.47**	0.48**	-0.50**	0.50**	0.14	-0.16	-0.08	0.40*	0.39*	0.39*
Hb	0.45**		0.96**	0.96**	-0.48**	0.41*	0.24	-0.38*	0.05	0.50**	0.75**	0.75**
Ht	0.47**	0.91**		0.92**	-0.49**	0.48**	0.21	-0.45**	0.10	0.51**	0.72**	0.72**
RBCs	0.43**	0.91**	0.84**		-0.40*	0.37*	0.33*	-0.44**	0.01	0.50**	0.74**	0.74**
LYMP	-0.41*	-0.36*	-0.31	-0.41*		-0.99**	-0.25	0.13	0.01	0.02	-0.27	-0.27
SEGMENT	0.34*	0.29	0.26	0.35*	-0.97**		0.17	-0.20	-0.05	0.01	0.28	0.29
STAFF	0.54**	0.33*	0.38*	0.35*	-0.37*	0.21		-0.18	-0.01	0.10	0.22	0.21
ESINO	0.01	0.23	0.08	0.23	0.10	-0.25	0.11		0.18	-0.43**	-0.43**	-0.44**
BASO	-0.20	-0.06	-0.04	0.01	0.09	0.04	-0.38*	-0.08		-0.20	-0.17	-0.18
GPX	0.24	0.19	0.23	0.35*	-0.09	0.08	0.13	0.05	0.17		0.88**	0.89**
CAT	0.25	0.55**	0.58**	0.63**	-0.40*	0.35*	0.41*	0.08	0.07	0.82**		0.99**
SOD	0.22	0.53**	0.55**	0.61**	-0.38*	0.34*	0.40*	0.08	0.07	0.84**	0.99**	

Hb: heamoglobiun, Ht: haematocrit, RBCs: red blood cells heamolycte, LYMP: lymphocytes, SEGMENT and STAFF: neutrophils, ESINO: eosinophils, BASO: basophils, GPX: glutathione peroxidase, CAT: catalase and SOD: superoxide dismutase.
** Correlation is significant at P≤0.01 level.
* Correlation is significant at P≤0.05 level.

antioxidant enzymes, blood haematological, correlations.

Table 5. Correlation coefficients among egg weight (EW) and egg quality traits for Leghorn (above diagonal) and Dandarawi (below diagonal) breeds.

	EW	**Alb%**	**Y%**	**Sh%**	**YC**	**YI**	**HU**	**SI**	**ST**	**ESG**	**SD**	**SWUSA**	**ESA**	**ESV**
EW		0.65**	0.67**	-0.22	0.01	0.23	-0.29	0.06	0.11	-0.22	0.05	0.07	0.99**	0.75**
Alb%	-0.12		-0.89**	-0.51**	-0.12	0.01	0.06	0.20	0.22	-0.51**	-0.32	-0.31	0.65**	0.55**
Y%	0.12	-0.94**		0.13	-0.01	0.08	0.05	-0.27	-0.36*	0.13	0.06	-0.06	-0.67**	-0.67**
Sh%	0.14	-0.73**	0.56**		0.35	-0.07	-0.13	-0.11	0.37*	0.99**	0.94**	0.93**	-0.22	0.10
YC	0.12	0.04	0.01	-0.10		0.19	-0.10	-0.03	-0.39*	0.45*	0.51**	0.48**	0.01	0.22
YI	-0.01	0.16	-0.11	-0.17	0.17		0.37*	-0.14	0.04	-0.07	0.04	0.06	0.23	0.17
HU	-0.45*	0.44*	-0.41*	-0.39*	0.26	0.39*		0.21	0.08	-0.03	-0.09	-0.10	-0.29	-0.18
SI	-0.08	-0.02	-0.06	-0.06	-0.26	-0.36*	0.13		0.19	-0.11	-0.08	-0.09	0.06	0.13
ST	0.27	-0.18	0.09	0.36*	0.14	-0.17	-0.03	0.21		0.36*	0.43*	0.41*	0.12	0.72**
ESG	0.14	-0.73**	0.50**	0.99**	-0.10	-0.17	-0.39*	0.06	0.37*		0.94**	0.93**	-0.22	0.10
SD	0.45*	-0.69**	0.48**	0.94**	-0.03	-0.14	-0.47**	0.01	0.37*	0.94**		0.99**	0.05	0.35
SWUSA	0.48**	-0.68**	0.48**	0.93**	-0.05	-0.12	-0.49**	0.01	0.37*	0.93**	0.99**		0.07	0.36*
ESA	0.99**	-0.11	0.12	0.14	0.12	-0.01	-0.45*	-0.10	0.27	0.14	0.45*	0.47**		0.75**
ESV	0.87**	-0.11	0.08	0.21	0.13	-0.16	-0.37*	0.10	0.68**	0.21	0.47*	0.49**	0.87**	

EW: Egg weight, Alb%: Albumen%, Y%: Yolk%, Sh%: Shell weight%, YC: Yolk Color, YI: Yolk index, HU: Haugh units, SI: Shape index, ST: Shell thickness. ESG: Egg specific gravity, SD: Shell density, SWUSA: Shell weight per unit surface area, ESA: Egg surface area and ESV: Egg shell volume.

** Correlation is significant at $P \leq 0.01$ level.

* Correlation is significant at $P \leq 0.05$ level.

Table 6. Correlation coefficients among egg weight (EW) and egg quality traits for Sinai (above diagonal) and Fayoumi (below diagonal) breeds.

	EW	**Alb%**	**Y%**	**Sh%**	**YC**	**YI**	**HU**	**SI**	**ST**	**ESG**	**SD**	**SWUSA**	**ESA**	**ESV**
EW		0.21	-0.24	-0.10	0.22	0.20	-0.16	0.32	0.13	-0.10	-0.03	-0.03	0.99**	0.75**
Alb%	0.43*		-0.87**	-0.69**	-0.24	0.40*	0.57**	-0.10	-0.10	-0.69**	-0.67**	-0.67**	0.21	0.10
Y%	-0.43*	-0.68**		-0.35	0.26	-0.36*	-0.44*	-0.02	-0.12	0.35	0.32	0.32	-0.34	-0.23
Sh%	-0.11	-0.55**	-0.10		0.01	-0.23	-0.50**	0.21	0.46*	0.99**	0.99**	0.99**	-0.10	0.13
YC	-0.13	0.05	0.07	-0.13		0.04	-0.16	0.18	-0.29	0.01	-0.01	-0.01	0.22	-0.04
YI	-0.10	-0.05	-0.25	0.43*	0.08		0.31	-0.07	0.04	-0.23	-0.22	-0.22	0.20	0.13
HU	-0.41*	-0.02	0.20	-0.19	0.09	0.18		0.07	-0.34	-0.50**	-0.52*	-0.52**	-0.37*	-0.36*
SI	-0.21	-0.30	0.05	0.50**	-0.07	0.28	-0.11		0.22	0.21	0.21	0.21	0.32	0.33
ST	-0.13	-0.07	-0.22	0.37*	-0.14	0.25	-0.27	0.51**		0.46**	0.47**	0.47**	0.13	0.69**
ESG	-0.22	-0.55**	-0.10	0.99**	-0.13	0.43*	-0.37*	0.49**	0.37*		0.99**	0.99**	-0.16	0.13
SD	0.17	-0.43*	-0.22	0.94**	-0.16	0.43*	-0.36*	0.41*	0.34	0.94**		0.99**	-0.03	0.18
SWUSA	0.19	-0.43*	-0.23	0.94**	-0.15	0.42*	-0.36*	0.40*	0.34	0.94**	0.99**		-0.03	0.18
ESA	0.99**	-0.43*	-0.43*	-0.22	-0.13	-0.10	-0.41*	-0.21	-0.13	-0.11	0.17	0.19		0.75**
ESV	0.38*	0.16	-0.44*	0.27	-0.20	0.22	-0.46*	0.31	0.85**	0.27	0.40*	0.40*	0.40*	

EW: Egg weight, Alb%: Albumen%, Y%: Yolk%, Sh%: Shell weight%, YC: Yolk color ,YI: Yolk index, HU: Haugh units, SI: Shape index, ST: Shell thickness. ESG: Egg specific gravity, SD: Shell density, SWUSA: Shell weight per unit surface area, ESA: Egg surface area and ESV: Egg shell volume.

** Correlation is significant at $P \leq 0.01$ level.

* Correlation is significant at $P \leq 0.05$ level.

antioxidant enzymes, blood haematological, correlations.

Table 7. Correlation coefficients among some blood parameters, antioxidant enzymes activities in red blood cells haemolycate, egg weight (EW) and egg quality traits regardless of the chicken breed.

	Hb	**Ht**	**RBCs**	**LYMP**	**SEGMENT**	**STAFF**	**ESINO**	**GPX**	**CAT**	**SOD**
EW	0.24**	0.24**	0.45**	-0.55**	0.58**	-0.36**	-0.45**	0.56**	0.55**	0.55**
Alb%	-0.33**	-0.33**	0.15	0.07	0.01	-0.42**	0.12	0.14	0.13	0.13
Y%	0.39**	0.39**	0.20*	-0.07	0.00	0.46**	-0.20	-0.23*	-0.22*	-0.22*
Sh%	0.03	0.03	0.04	-0.02	0.00	0.11	-0.09	0.13	0.12	0.12
YC	0.25**	0.25**	0.09	0.09	-0.14	0.39**	0.00	-0.44**	-0.42**	-0.43**
YI	-0.29**	-0.29**	-0.20*	0.14	-0.10	-0.24**	0.18	0.05	0.04	0.03
HU	-0.25**	-0.29**	-0.09	-0.02	0.07	-0.37**	0.08	0.24**	0.25**	0.24*
SI	0.03	0.03	-0.02	0.03	-0.04	0.09	0.02	-0.06	-0.05	-0.06
ST	0.20*	0.20*	0.02	0.05	-0.10	0.40**	0.02	-0.16	-0.15	-0.16
ESG	0.03	0.03	-0.03	-0.02	0.01	0.11	0.09	0.13	0.13	0.13
SD	0.10	0.09	0.08	-0.16	0.15	0.02	-0.03	0.27**	0.27**	0.26**
SWUSA	0.10	0.49**	0.10	-0.18*	0.17	0.01	0.02	0.29**	0.28**	0.28**
ESA	0.24**	0.24**	0.46**	-0.55**	0.58**	-0.36**	-0.45**	0.56**	0.55**	0.55**
ESV	0.32**	0.32**	0.34**	-0.37**	0.35**	-0.20*	-0.31**	0.30**	0.29**	0.29**

Hb: heamoglobiun, Ht: haematocrit, RBCs: red blood cells heamolycte, PCV: packed cells volume, TLC: total leukocytes, LYMP: lymphocytes, SEGMENT and STAFF: Neutrophils, ESINO: eosinophils, GPX: glutathione peroxidase, CAT: catalase and SOD: superoxide dismutase. Alb%: EW: Egg weight, Alb%: Albumen%, Y%: Yolk%, Sh%: Shell weight%, YC: Yolk color ,YI: Yolk index, HU: Haugh units, SI: Shape index, ST: Shell thickness. ESG: Egg specific gravity, SD: Shell density, SWUSA: Shell weight per unit surface area, ESA: Egg surface area and ESV: Egg shell volume.

** Correlation is significant at $P \leq 0.01$ level.

* Correlation is significant at $P \leq 0.05$ level.

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الملخص العربي

اختلافات أنواع من الدجاج ومعاملات الارتباط لنشاط الإنزيمات المضادة للأكسدة وبعض المقاييس الفسيولوجية والصفات الإنتاجية

2. معاملات الارتباط

على عبد العظيم وجيهان شعبان فرحات
كلية الزراعة بالفيوم-قسم إنتاج الدواجن-جامعة الفيوم

أجريت هذه الدراسة بهدف قياس معاملات الارتباط لنشاط الإنزيمات المضادة للأكسدة (الجلوتاثيون بيرواوكسيديز و السوبرأوكسيدديسميوتيز والكاتيليز) وبعض المقاييس الفسيولوجية (الهيموجلوبين و والهيماتوكريت و كرات الدم الحمراء و كرات الدم البيضاء) وبعض الصفات الإنتاجية وتشمل وزن الجسم و وزن البيض وصفات جودة البيضة والقشرة في سلالات: الدندراوى و الفيومي و السينا و اللجهورن الأبيض عند عمر 38 أسبوع.

وتتلخص أهم النتائج المتحصل عليها فيما يلي:

كانت هناك اختلافات معنوية في نشاط الإنزيمات المضادة للأكسدة في وكرات الدم الحمراء وبعض المقاييس الفسيولوجية والإنتاجية المدروسة بين الأنواع المختلفة. أظهرت قيم معاملات الارتباط لنشاط الإنزيمات المضادة للأكسدة وبعض المقاييس الفسيولوجية وبعض الصفات الإنتاجية قيم معنويا ومدى واسع من التباين بين السلالات المختلفة. ارتبط وزن الجسم ارتباط موجب و معنويا (P≤0.01) مع نسبة الهيموجلوبين والهيماتوكريت وكرات الدم الحمراء في كل السلالات تحت الدراسة. ارتبط وزن الجسم ارتباط موجب و معنويا (P≤0.01) مع كرات الدم البيضاء من نوع السيجمانت في سلالات: الفيومي و السينا و اللجهورن الأبيض بينما كانت القيم غير معنوية في سلالة الدندراوى. كان معامل الارتباط بين وزن الجسم مع كرات الدم البيضاء من نوع الاستف موجب و معنويا (P≤0.01) في سلالة الفيومي بينما كانت القيم غير معنوية بالنسبة لباقي السلالات. سجلت قيم معاملات الارتباط بين وزن الجسم مع لنشاط الإنزيمات المضادة للأكسدة أعلى قيم معنوية بالنسبة لسلالة السينا. معاملات الارتباط بين وزن الجسم ونشاط إنزيمي السوبرأوكسيدديسميوتيز والكاتيليز كان موجب ومعنوي في كل السلالات ماعدا الفيومي. أظهرت قيم معاملات الارتباط لنشاط الإنزيمات المضادة للأكسدة ومعظم المقاييس الفسيولوجية قيم معنويا ومدى واسع من التباين بين السلالات المختلفة. أيضا ارتبطت معظم المقاييس الفسيولوجية مع بعضها ارتباط معنوي وعالي ويعتمد على السلالة. كانت قيم معاملات الارتباط بين نشاطات الإنزيمات المضادة للأكسدة مع بعضها معنوية وموجبه في كل السلالات.

والخلاصة أن هناك ارتباط معنوي بين نشاط الإنزيمات المضادة للأكسدة ومعظم المقاييس الفسيولوجية و الصفات الإنتاجية وهذا الارتباط يعتمد على التركيب الوراثي و انه يمكن توظيف هذا الارتباط بالإضافة إلى الاختلافات بين السلالات في برامج التربية والانتخاب المختلفة لإنتاج سلالات مقاومه لمخاطر الأكسدة مع الأخذ في الاعتبار الصفات الإنتاج