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Original Article

Comparison of Physiological and Biochemical Characteristics in Two Quail Breeds and Their Plumage

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ABSTRACT

The aim of this study was to determine the effect of quail's breed (European vs. local) and line (white vs. dark) on body weight as well as some hematological and biochemical blood parameters. Forty female quails of two lines (20 white and 20 brown) within each breed (European and Local) were selected randomly and used in the present investigation, aiming to compare between them for physio-biochemical characteristics. All target birds were slaughtered at 12 weeks old. Quail blood samples (8 ml) were taken at the time of slaughter and placed in two distinct types of tubes. Biochemical, liver, renal, immunity and white blood cells parameters were investigated and measured using kits from Roche Diagnostics Company by automated method. The results showed significantly ($p<0.01$) higher body weight- as expected- in European birds (325.7 vs. 270.1 gm); for biochemical parameters, there were insignificant ($p>0.05$) differences either between both breed or between both lines, except glucose (301.15 vs. 323.25 mg/dl) and cholesterol (151.095 vs. 205.285 mg/dl) for line effect ($p<0.01$), where white line surpassed dark one. Liver function tests weren't differed significantly ($p>0.05$) between breeds and lines; except albumen values which differed significantly ($p<0.05$) between local and European breed (1.484 and 1.475 g/dl, respectively), and between dark and while line (1.408 and 1.551 g/dl, respectively). However, all renal function tests were not differed significantly ($p>0.05$); whereas immunity indicator (IgA) for the European breed surpassed significantly ($p<0.05$) local one (2.001 vs. 1.102 mg/dl), and dark line surpassed significantly white one (2.002 vs. 1.0101 mg/dl). All blood cell tests weren't differed insignificantly ($p>0.05$). A significant interaction between breed and line was observed just for Immunoglobulin M (IgM), heterophils and the heterophil to lymphocyte ratio (H/L ratio). As conclusion, the physiological variation is limited between quail breed or lines.

Keywords: European Quail, Local Quail, serum biochemistry, hematology, Immunity.

1 Introduction

Quail is the smallest poultry species bred mainly for meat and egg production, particularly in rural areas with limited resources [1]. Since they are an affordable and valuable source of animal protein [2, 3]. In addition, quail are utilized as laboratory animals because to their tiny size, brief reproductive period, lack of large breeding area [4, 5], rapid growth, ease of handling [6], and resistance to common diseases in poultry [7].

Physiological blood parameters are essential in determining the normal physiological status of quail, where a wide range of tests and values related to it [8]. Blood is a well-known indicator of the body's physiological state, reflecting the health and pathological conditions of the individual [9]. Numerous factors, including sex and age variation, sexual maturity, breed, nutrition, productive status, season, stress status, and blood diseases, can influence the blood's components [10].

Blood biochemical analysis is a valuable technique for assessing an animal's health because it helps in both clinical disease monitoring and diagnosis [11]. In many domestic livestock species, serum biochemical profiling has been used to detect subclinical disease and track herd health [10]. Hematological and immunological parameters were chosen in this study because they provide important indicators of the physiological, metabolic, and health status of the quail. Blood glucose and cholesterol parameters are important indicators for metabolic status and stress response in poultry and quail [12]. Liver enzymes, including alanine aminotransferase (ALT) and aspartate aminotransferase (AST), are commonly used as indicators of liver function and its healthy case [13]; while renal indicators, including creatinine and uric acid, are important markers for assessing kidney function in birds to eliminate kidney failure [14]. Immunoglobulin analysis is important because it reflects the immune response and disease resistance in poultry [15]; whereas differential white blood cell

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(WBC) counts were analyzed because blood parameters are considered pathophysiological indicators of the body's overall health status [16].

The present study aimed to evaluate the effects of quail's breed (European vs. local), and plumage color line (white vs. dark), on body weight as morphologic state and on some hematological and biochemical blood parameters as healthy case.

2 Materials and Methods

2. 1 Bird's Housing and Managements

Forty female quails of two lines (white and brown) within each breed (European and Local) were selected randomly and used in the current investigation; in other word 10 birds for each subgroup, and the single bird was considered as one replication or experimental unit within the mentioned subgroup. The experiment was conducted in Poultry farm of Animal Production Dept, College of Agricultural Engineering Sciences, The University of Duhok, Kurdistan Region-Iraq. Through the period of study, which was a part of whole study included both growth and egg yield productive performance from (June to December, 2024). All birds were kept as family in identical cages measuring 60 × 60 × 30 cm in the same room, and management procedures were maintained as consistent as possible.

Feed and water were submitted *ad libitum* during the experimental period, according to [17], the feed consist of three different rations; starter (2900 ME/kg & 24% CP) from 1 day to 21 days old; grower (2700 ME/kg & 22% CP) from 22-42 days old; and layer or breeder (2800 ME/kg & 18% CP) from 43 days to the end of the trial, as indicated in Table 1 [18].

The birds were exposed to light 24 hours a day for first three days, and then 23 hours a day from the 4th to the 42nd day old; however, the lighting schedule was 16 hours a day during the laying time and remained the same until the end of the experiment. The birds' growing house's temperature gradually decreased from 36 °C to 24 °C between the first three days and the fourth week of age; the temperature was then maintained between 24 and 22°C until the study was over.

2. 2 Blood Hematology and Plasma Biochemistry

All target birds were slaughtered at 12 weeks of age. Quail blood samples (8 ml) were taken at the time of slaughter and placed in two distinct types of tubes: 2 ml were placed in EDTA tubes, which are anticoagulant tubes used for differential leukocyte counts (DLC). As stated in [19], fresh Leishman stain was used to color blood smears for DLC. To separate the blood serum, 6 ml of blood was put in the other tubes (Plane tubes), which do not contain anticoagulants, centrifuged for 15 minutes at 3000 rpm, and then stored in the Eppendorf tubes at -20°C until the biochemical tests were completed.

Blood serum was separated by centrifuging 6 ml of blood in the other tubes (plane tubes), which do not contain anticoagulants, for 15 minutes at 3000 rpm. The serum was then stored in Eppendorf tubes at -20°C until the biochemical tests were carried out. Glucose (mg/dl), cholesterol (mg/dl), triglycerides (mg/dl), HDL (mg/dl), total proteins (TP, g/dl), albumin (Alb, g/dl), urea (mg/dl), creatinine (mg/dl), AST (IU/L), ALT (IU/L), IgA (mg/dl) and IgM (mg/dl) were measured using kits from Roche Diagnostics Company by automated method with biochemistry auto analyzer COBAS INTEGRA® 400 plus, Switzerland at laboratory.

The globulin (Glob) values were calculated by subtracting the values of Alb from the corresponding values of TP; and the Alb/Glob ratio was then calculated using the BCG or Biuret method [20, 21].

Table 1: Rations and its chemical composition which were offered to the quail chicks, during the experimental periods [18].

Ingredients %	Starter (0-4 wks.)	Grower (4-6 wks.)	Breeder (6 wks.-end trial)
Yellow corn	40	50	60
Soybean meal 44%	50	35	22
Wheat bran	3.4	7.2	4.7
Vegetable oil	4	3.5	2
Limestone	1.5	3	9
Di-calcium phosphate	0.8	1	2
Salt (NaCl)	0.2	0.2	0.2
Vitamins and Minerals	0.1	0.1	0.1
Total	**100**	**100**	**100**
Chemical Composition			
K. cal. ME / Kg diet	2850	2850	2737
Crude Protein %	26	21	15.7
C/P ratio	109.6	135.7	174.3
Standard C/P ratio	110	140	175
***Ca*$^{++}$**	0.9	1.48	3.93
P	0.63	0.64	0.74

2. 3 Statistical analysis

The gathered data of blood samples as affected by breed, line and their interaction were analyzed using SPSS software. General Linear Model (GLM) was applied according to the following model:

$$Y_{ijk} = \mu + B_i + L_j + (B*L)_{ij} + e_{ijk}$$

where Y_{ijk} = an observation live blood samples, μ = Overall mean, B_i = Effect of the Breed (Local vs. European), L_j = Effect of Line (white and dark), $(B*L)_{ij}$ = interaction between Breed and Line and e_{ijk} = Random error.

The significant means of each factor were separated using Duncan's multiple range test [22].

3 Results and Discussion

3. 1 Body weight

Table 2, shows BW and the studied blood parameters of European and local quails as overall means, affected by breed and influenced by line; however, the interactions between breed and line for all characters were expressed as Table 2. It could be noticed from Table 2, that BW of European was significantly ($p<0.01$) higher than their local counterpart (325.7 vs. 270.1 g); while dark line (307.7 g) had surpassed white quail (288.1 g) numerically ($p>0.05$); and the interaction between breed - line wasn't significant ($p>0.05$) as mentioned Table 2.Such result is well known because European quail has bigger size than local; this finding was supported by Ibrahim and Al-Neemy [23], who observed a significant increase in BW of European quail compared to the local; also, according to Amana et al. [24] the difference between BW of different genotypes might account for the variance in their body sizes. Various studies pointed out that the dark line had a comparatively higher body weight than the other lines under analysis [7, 25-27], this may be explained by the dark quail's high propensity for rapid growth and their ability to store protein and fats. In addition to the fact that dark quails are less mobile, fearful, and aggressive [28]. In contrast to the current study's findings, Shafik et al. [29] found that the white quail had a noticeably greater final body weight than the brown quail. Taking into account the interaction between quail breed and plumage color, the dark and white European quail prevailed over the white and dark local quail in terms of weight during the 12-week experiment. These findings ensure that feather color significantly affects body weight throughout the study [7, 30-34].

3. 2 Blood Sugar and Lipid profile

Regarding the blood sugar and lipid profile, all studied parameters weren't affect significantly ($p>0.05$) by breed; while just glucose and cholesterol levels significantly ($p<0.01$) increased in white line (323.25 & 205.29 mg/dl) compared to the dark line (301.15 & 151.1 mg/dl); and the interaction between breed and line for all studied parameters were insignificant ($p>0.05$) (Table 2). The present results are in agreement with Khawaja et al. [35] regarding HDL and triglyceride levels; also, these results were consistent with those obtained by Fathi et al. [36] and Kanabala et al. [37], who showed that white quails had significantly higher cholesterol levels than gray quails. Conversely, Japanese quails with brown feathers showed greater serum glucose concentrations than those with grey or white feathers [37]. Similarly Kalaff [38] found that throughout the summer, local black quail had substantial levels of glucose and cholesterol due to the stress on their metabolism produced by high temperatures [38]. El-Ghalid [39] suggests that the existence of more glucagon-secreting alpha cells in the islets of Langerhans may be another factor contributing to the high serum glucose levels in chicks of all three (brown, grey- and white-feathered). On the other hands, the present results contradicted with those presented by Al-Kafajy et al. [7] and Khawaja et al. [35], who discovered a non-significant variation in blood glucose and cholesterol. Furthermore, there was no discernible difference in the levels of HDL, triglycerides, cholesterol, and glucose between the European and local quail breeds. These results were comparable to those obtained by Abdul-Majeed and Abdul-Rahman [40] showing that breed and age had no significant impact on glucose and cholesterol. Similarly, non-significant differences in plasma cholesterol levels between the parent generations of Japanese quails and their crosses were documented by Rezvannejad [41]. On the contrary, there were notable variations in blood cholesterol levels between imported and local Japanese quail flocks, according to Jatoi et al. [42]. However, blood biochemical analysis is a useful technique for evaluating qualities in breeding for high production [43]. It also serves as an indication of animal health and helps in diagnosis of diseases and clinical monitoring [11].

Unfortunately, there aren't much published data on this bird's biochemical records [44] which restricts the issue of comparison. This restriction might result from the bird's tiny size and high degree of mobility, which make sample collecting more technically challenging [45].

3. 3 Liver function

In respect to liver function tests in Local and European quail's breeds, their lines and their interaction, which are presented in Table 3, indicate that just Albumin and Albumin /Globulin (A/G) ratio are differed significantly between breed ($p<0.05$) and the same parameters differed significantly ($p<0.01$) between lines for Albumin and significantly ($p<0.05$) for A/G ratio, but their interactions weren't differed significantly ($p>0.05$) as shown in Table 3; while all other parameters weren't differed significantly ($p>0.05$) between breed, lines and their interactions. However, as known hepatic function can be determined by the levels of albumin, globulin, total protein, ALT, and AST [46]. According to Abdul-Majeed and Abdul-Rahman [40] age and breed (white and light brown) had no significant effects on ALT and AST, which is consistent with our findings. They are also align with Al-Kafajy et al. [7], who compared three lines of quail plumage color—black, white, and brown—and found no apparent difference between serum values AST and ALT. Moreover, the results reported here corresponded with those found that quail variety had significant effects on albumin content, with the white strain having higher

albumin concentration than the brown strain [47]. Also, the results of the current study, are also consistent with those of Hassan [48], who showed that the plasma albumin increased with age in female Japanese Quails. Other researchers [7, 36, 40] observed no significant alteration in albumin, the albumin/globulin ratio, which is in conflict with the results of this research, but it is true for total protein and globulin.

3. 4 Renal function tests and Immunity indicators

Table 4, represents renal function tests and immunity indicators (IgM and IgA). The results appeared a significant difference ($p<0.05$) for IgA between breeds and lines, while the interaction between them was insignificant ($p>0.05$). On the other hand, the interaction effect between breed and line for IgM was significant ($p<0.05$). However, all other parameters had no significant differences ($p>0.05$) either between breeds, lines and their interactions. For IgA, the European breed surpassed significantly local one (2.001 vs. 1.102 mg/dl), and dark line surpassed significantly white one (2.002 vs. 1.0101 mg/dl); however, similar to the present investigation were indicated that the breed and line variety had no significant impact on urea and creatinine levels [7]. The factors that may contribute to the observed variations are unknown, however they might be related to the population type and the estimation method, which may somewhat alter the observed data [49].

3. 5 Differential Leukocyte Count

The clinical and immunological health of birds is commonly assessed using WBC counts, both total and differential [50, 51]. For all hematological measurements which are presented in Table 5, there were insignificant differences ($p>0.05$) either between breed or line. However, the interaction impact between breed and line for heterophils, and the heterophil to lymphocyte ratio (H/L ratio) was significant ($p<0.05$). These finding were consistent with those of Abdul-Majeed and Abdul-Rahman [40], who determined that age and breed had no effect on the differential leukocyte count, but sex did. Additionally, these findings were in line with those of Tollba and El- Nagar [52], who observed that the number of heterophil cells did not significantly alter, which may be related to species and age. However, the eosinophil and basophil counts in black local quail were not significant during or prior to sexual maturation [38].

Table 2: Breed and lines effects on body weight, blood sugar and lipid profile in quail.

Overall Mean						
Parameters		**B.W (gm)**	**Glucose (mg/dl)**	**Cholesterol (mg/dl)**	**Triglyceride (mg/dl)**	**HDL (mg/dl)**
Mean		297.900	312.200	178.190	839.350	43.783
± SE		5.639	3.569	8.286	56.454	6.197
Effect of Breed						
Breed		**B.W (gm)**	**Glucose (mg/dl)**	**Cholesterol (mg/dl)**	**Triglyceride (mg/dl)**	**HDL (mg/dl)**
Local		270.100 ^{b}	319.150	181.385	839.150	47.585
European		325.700 ^{a}	305.250	174.995	839.550	39.980
± MSE		7.974	5.048	11.719	79.837	8.764
***p* value**		0.001**	0.059 ^{ns}	0.702 ^{ns}	0.997 ^{ns}	0.543 ^{ns}
Effect of Line						
Line		**B.W (gm)**	**Glucose (mg/dl)**	**Cholesterol (mg/dl)**	**Triglyceride (mg/dl)**	**HDL (mg/dl)**
Dark		307.700	301.150 ^{b}	151.095 ^{b}	844.150	41.245
White		288.100	323.250 ^{a}	205.285 ^{a}	834.550	46.320
± MSE		7.974	5.048	11.719	79.837	8.764
***p* value**		0.091 ^{ns}	0.004**	0.002**	0.933 ^{ns}	0.685 ^{ns}
Interaction Effect (Breed*Line)						
Parameters		**B.W (gm)**	**Glucose (mg/dl)**	**Cholesterol (mg/dl)**	**Triglyceride (mg/dl)**	**HDL (mg/dl)**
Local	**Dark**	284.4	309	160.68	892	44.16
	White	255.8	329.3	202.09	786.3	51.01
European	**Dark**	331	293.3	141.51	796.3	38.33
	White	320.4	317.2	208.48	882.8	41.63
± MSE		11.278	7.139	16.572	112.907	12.394
***P* Value**		0.430 ^{ns}	0.802 ^{ns}	0.446 ^{ns}	0.400 ^{ns}	0.887 ^{ns}

Means having different letters within each parameter (column) are differed significantly.
*Ns=non-significant ($p>0.05$); *= significant ($p<0.05$), ** = significant ($p<0.01$)*
*Abbreviations: B.W = **Body Weight,** HDL = High-Density Lipoprotein., gm = gram, and mg/dl = milligrams per deciliter*

Table 3: Effect or impact of Breed and lines on liver function tests Local and European quails.

Overall Mean							
Parameters		**ALT (IU/L)**	**AST (IU/L)**	**Total protein (g/dl)**	**Albumin (g/dl)**	**Globulin (g/dl)**	**A/G ratio**
Mean		3.185	269.386	4.072	1.480	2.593	0.593
± SE		0.356	12.254	0.103	0.022	0.093	0.021
Effect of Breed							
Breed		**ALT (IU/L)**	**AST (IU/L)**	**Total protein (g/dl)**	**Albumin (g/dl)**	**Globulin (g/dl)**	**A/G ratio**
Local		3.025	270.175	4.009	1.484 [a]	2.525	0.618 [a]
European		3.345	268.597	4.136	1.475 [b]	2.661	0.569 [b]
± MSE		0.504	17.330	0.146	0.032	0.131	0.030
***p* value**		0.656 [ns]	0.656 [ns]	0.544 [ns]	0.045*	0.185 [ns]	0.042*
Effect of Line							
Line		**ALT (IU/L)**	**AST (IU/L)**	**Total protein (g/dl)**	**Albumin (g/dl)**	**Globulin (g/dl)**	**A/G ratio**
Dark		3.430	248.002	3.922	1.408 [b]	2.514	0.573 [b]
White		2.940	290.770	4.223	1.551 [a]	2.672	0.613 [a]
± MSE		0.504	17.330	0.146	0.032	0.131	0.030
***p* value**		0.496 [ns]	0.090 [ns]	0.153 [ns]	0.03*	0.398 [ns]	0.042*
Interaction Effect (Breed*Line)							
Parameters		**ALT (IU/L)**	**AST (IU/L)**	**T. Protein (g/dl)**	**Albumin (g/dl)**	**Globulin (g/dl)**	**A/G ratio**
Local	**Dark**	2.96	250.21	3.834	1.44	2.394	0.61
	White	3.09	290.14	4.184	1.528	2.656	0.626
European	**Dark**	3.9	245.794	4.009	1.376	2.633	0.536
	White	2.79	291.4	4.262	1.574	2.688	0.601
± MSE		0.712	24.508	0.206	0.045	0.185	0.042
***P* Value**		0.390 [ns]	0.908 [ns]	0.816 [ns]	0.227 [ns]	0.580 [ns]	0.567 [ns]

Means having different letters within each parameter (column) are differed significantly.
*Ns=non-significant (p>0.05); *= significant (p<0.05), ** = significant (p<0.01)*
Abbreviations: ALT = Alanine aminotransferase, AST = Aspartate aminotransferase,
T. Protein = Total protein, and A/G ratio = Albumin/Globulin ratio.

Table 4: Breed and line effects on renal function tests, IgM and IgA in Local and European quails.

Overall Mean				
Parameters	**B. urea (mg/dl)**	**S. Creatinine (mg/dl)**	**IgM (mg/dl)**	**IgA (mg/dl)**
Mean	3.408	0.032	140.256	1.553
± SE	0.419	0.004	35.898	0.188
Effect of Breed				
Breed	**B. urea (mg/dl)**	**S. Creatinine (mg/dl)**	**IgM (mg/dl)**	**IgA (mg/dl)**
Local	3.795	0.031	93.558	1.102 [b]
European	3.020	0.034	186.954	2.001 [a]
± MSE	0.593	0.006	50.768	0.266
***p* value**	0.361 [ns]	0.668 [ns]	0.202 [ns]	0.022 *
Effect of Line				
Line	**B. urea (mg/dl)**	**S. Creatinine (mg/dl)**	**IgM (mg/dl)**	**IgA (mg/dl)**
Dark	3.425	0.035	140.606	2.002 [a]
White	3.390	0.030	139.906	1.101 [b]
± MSE	0.593	0.006	50.768	0.266

***p* value**		0.967 ns	0.501 ns	0.992 ns	0.022 *
Interaction Effect (Breed*Line)					
		B. urea (mg/dl)	**S. Creatinine (mg/dl)**	**IgM (mg/dl)**	**IgA (mg/dl)**
Local	**Dark**	3.35	0.029	186.406 b	1.302
	White	4.24	0.032	0.709 d	0.901
European	**Dark**	3.5	0.041	94.805 c	2.701
	White	2.54	0.027	279.103 a	1.301
± MSE		0.838	0.008	71.796	0.377
P Value		0.277 ns	0.300 ns	0.014 ns	0.193 ns

Means having different letters within each parameter (column) are differed significantly.
*Ns=non-significant (p>0.05); *= significant (p<0.05), ** = significant (p<0.01)*
Abbreviations: B. urea = Blood urea, S. Creatinine = Serum creatinine,
IgM = Immunoglobulin M, and IgA = Immunoglobulin A

Table 5: Breed and lines effects on white blood cells count in Local and European quails.

Parameter		**Heterophils**	**Lymphocytes**	**H/L**	**Monocytes**	**Eosinophils**	**Basophils**
Overall mean		29.715	64.061	0.480	3.013	1.836	1.375
± MSE		1.1	1.331	0.028	0.419	0.232	0.167
Effect of Breeds							
Breed		**Heterophils**	**Lymphocytes**	**H/L**	**Monocytes**	**Eosinophils**	**Basophils**
Local		29.200	64.400	0.477	2.900	2.100	1.400
European		30.230	63.722	0.483	3.127	1.571	1.349
± MSE		1.51	1.88	0.39	0.56	0.297	0.231
***P* value**		0.644 ns	0.801 ns	0.789 ns	0.266 ns	0.881 ns	0.911 ns
Effect of Line							
Line		**Heterophils**	**Lymphocytes**	**H/L**	**Monocytes**	**Eosinophils**	**Basophils**
White		29.486	64.600	0.475	2.971	1.771	1.171
Dark		29.944	63.522	0.484	3.056	1.900	1.578
± MSE		1.55	1.88	0.040	0.59	0.324	0.235
***P* value**		0.837 ns	0.69 ns	0.882 ns	0.921 ns	0.784 ns	0.238 ns
Interaction Effect (Breed*Line)							
		Heterophils	**Lymphocytes**	**H/L**	**Monocytes**	**Eosinophils**	**Basophils**
European	**Dark**	32.89 a	60.444	0.551 a	3.111	2.0	1.556
	White	27.57 b	67	0.414 b	3.143	1.143	1.143
Local	**Dark**	27.0 b	66.6	0.416 b	3.0	1.8	1.600
	White	31.4 a	62.2	0.537 a	2.8	2.4	1.200
± MSE		2.21	2.48	0.055	0.83	0.44	0.36
***P* value**		0.038 *	0.052 ns	0.031 *	0.891 ns	0.13 ns	0.985 ns

Means having different letters within each parameter (column) are differed significantly.
*Ns=non-significant (p>0.05); *= significant (p<0.05), ** = significant (p<0.01)*
Abbreviations: H/L = Heterophil/Lymphocyte ratio

Conclusion

It could be concluded from the present investigation, that the physio-chemical and hematological and immunity parameters between both studied breeds and lines were almost similar, except albumen measure which recorded significantly (p<0.01) higher values in local breed and white line; also, glucose and cholesterol parameters were significantly (p<0.01) recorded higher values in white compared to dark line. Indeed, body weight trait as expected was higher in European breed compared to local one. Likewise, IgA level was greater in European breed and dark line. In other word, the physiological variation is limited or within restricted range, either between quail breed or lines.

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Conflicts of Interest

None.

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