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Genotype-Associated Variations in Hematology, Serum Metabolites and Carcass Characteristics in Local, ISA Brown and Rose Chickens

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Annotation: The paper tested hematological indices, serum biochemical parameters, and carcass traits in three different chicken genotypes i.e. local chickens, ISA-Brown (layer-type), and Rose (broiler-type). The design was properly randomized, where 18 market-sourced birds were used, six per genotype. Hematological variables assayed were red and white blood cell counts, hemoglobin concentration, packed cell volume, and the erythrocyte indices were mean corpuscular volume and mean corpuscular hemoglobin. Serum measurements included glucose level, total protein and total cholesterol. The weights of carcass mass, specific cut-up areas and weights of edible organs were taken after slaughter. The statistical analysis showed that there were no significant differences in the three genotypes in terms of red blood cell count, white blood cell count, hemoglobin level, and packed cell volume. On the other hand, erythrocyte indices had significant differences: the mean corpuscular volume was higher in local chicken, and the mean corpuscular hemoglobin concentration was higher in the case of ISA-Brown and Rose chicken. There are also significant differences between serum parameters of glucose, total protein and cholesterol. The ISA-Brown chickens were found to have higher weights of the breast, thighs, and wings as compared to the local chickens, which had higher weights of the gizzard. It was found that there were strong positive relationships between the weights of the breast and thigh with the serum glucose and cholesterol levels. To conclude, it is possible to state that significant physiological, metabolic, and carcass-related differences were observed among the investigated genotypes. These differences seem to be attributed by a difference in metabolic status and previous management habits instead of pre-existing genetic differences. Therefore, the results highlight the importance of the type of chicken in the comprehension of hematological and biochemical features.

Keywords: hematology; serum metabolites; glucose; cholesterol; carcass traits; correlation.

Introduction

Strict genetic selection and breeding selection programs have significantly changed the modern poultry production systems in that they strive to produce large biological, physiological and metabolic differences between the genotypes of chicken. Broiler strains have been bred selectively to achieve rapid growth, high feed ratio and maximum breast muscle yield as compared to layers strains which have been selected mostly with regard to long-term high egg production and metabolic homeostasis. Conversely, the populations of domestic hens that were not subjected to such powerful selection forces tend to be more resilient to environmental stresses and changing management policies (Tavarez and Solis de los Santos, 2016; Tallentire et al., 2016). It has been reported that comparative analyses of ancient and modern commercial breeds have recorded significant increases in the growth performance, carcass yield and grains utilization, which can directly be attributed to cumulative genetic selection (Havenstein et al., 2003a, 2003b).

The hematological and serum biochemical parameters are viable and popular indices of the physiological condition, the metabolic processes, and general health in birds. The evidence of oxygen-carrying capacity and hematopoietic activity can be found in red and white blood cell counts, the concentration of hemoglobin, the packed cell volume, and the erythrocyte indices. On the same note, serum metabolites such as glucose, total protein and cholesterol are used to indicate energy metabolism, protein and lipid synthesis and growth performance, and they have close associations with economically important characteristics in chickens (Scanes, 2009 Al-Khaldani and Al-Jabari, 2022).

The birds have unique metabolic features in contrast to the mammals especially serum glucose and lipid metabolism. Avian species have relatively high blood glucose levels at baseline physiological concentrations, which is due to variation in insulin responsiveness and endocrine regulation (Braun and Sweazea, 2008). In addition, hepatic lipogenesis is also a part of the avian metabolism in which the cholesterol and triglycerides made in the liver are transported into the growing egg yolk (Naber, 1976). Therefore, the dissimilar metabolic pathways in the level of these types of chickens might be noted in the dissimilar serum biochemical profiles.

The features of the carcasses and the ratio of edible organs have an economic and biological interest. The distribution of muscle mass in breast, thigh and wing carcass cuts is largely determined by historical selection and growth patterns especially among broiler and layer genotypes (Havenstein et al., 2003b; Tavárez and Solis de los Santos, 2016). Also, there are visceral organs, including liver, heart, and gizzard, which are important towards metabolism, cardiac activity, and digestion. The formation of gizzards, especially, is also condition-dependent to diet and feeding history, hence, controlling digestive efficiency and nutrient uptake (Svihus, 2011).

Correct interpretation of hematological and biochemical parameters should also be based on the right ranges of the population because the values may differ by type, age, management system and mode of analysis in chicken. Studies of both backyard and commercial laying hens have emphasized the importance of using context-specific reference ranges and pointed out the inconsistency between diagnostic analyzers (Board et al., 2018; Sauer et al., 2020 **;** Zangana et al., 2024**).** In this regard, cross-comparisons across varieties must be done with care keeping in mind physiological backgrounds and practices in management.

Even though research has been conducted widely on the commercial broiler and layer strains, little comparative information has been made to incorporate hematological indices, serum metabolites, and carcass characteristics between native chickens and commercial lines. With this regard, the current research was conducted to compare the selected hematological parameters, serum biochemical traits, carcass parameters, and edible organs weights of the local chickens, the ISA Broom layer-type, and the Rose broiler-type chickens, and also to assess the relationship between the phenotypic traits of the selected parameters.

Materials and Methods

Place of the experiment and time of the experiment.

The current study was conducted at the laboratory of the department of life sciences of the college of education and women of the Al -Kirkuk university, Iraq, in March 2025.

Birds of experiment and design.

Eighteen chickens were obtained in the local market and then divided into three categories, i.e., local (native) chickens, ISA Brown (layer-type), and Rose (broiler-type). There were six people in each group and an experimental unit of one bird. A totally randomized design (CRD) was used in the study. Since birds that were sourced in the market have variance in their previous management factors including feeding history and age, complete standardization of the same could not be achieved. As such, the study was undertaken in the form of a comparative physiological study in order to explain inter-type differences within the same sets of conditions of analysis.

Blood examination and hematological examination.

Each bird had blood sampled on his/her wing vein and put in heparinized tubes to be analyzed hematologically. Measured parameters included the following; red blood cell count (RBC), white blood cell count (WBC), hemoglobin concentration (Hb), packed cell volume (PCV), mean corpuscular volume (MCV), and mean corpuscular hemoglobin (MCH). Results are in the form of mean values and standard error (SE).

Biochemical analysis and serum preparation.

Separating serum was done by letting plain tubes of blood, without the use of anticoagulant, to clot at ambient temperature. Clotted blood was centrifuged at 3000 rpm over 20minutes after which the serum was extracted and stored at -20 o C awaiting analysis. The concentrations of glucose, total protein, and total cholesterol in the serum were measured using diagnostic kits that were commercially available, according to the instructions of the manufactures.

The characteristics of carcass and the size of edible organs.

Pre-slaughter body weight of each bird was registered. Then birds were slaughtered in the traditional way, evisceration weight and carcass weight were assessed. The weights of carcass were then divided into the breast, thigh, and wing. The visceral cavity was opened, liver, heart and gizzard weighed and recorded. Information regarding the weights of carcass and organs are in mean values.

Correlation analysis

The statistical tests conducted were Pearson correlation coefficients to determine phenotypic correlations of the chosen traits: serum glucose, total cholesterol, weight of the breast and weight of the thigh.

Statistical analysis

The Statistical Analysis System (SAS) was used in conducting statistical analyses. The analysis of variance (ANOVA) was done on a completely randomized basis. In cases where statistically significant differences were determined, treatment means were compared with the help of the multiple range test presented by Duncan. Significance levels were established at P 0.05 between the groups and level of P 0.05 or P 0.01 when establishing any significant correlation.

Results and Discussion

Hematological parameters

The table 1 shows the hematology of the three types of chicken. There were no statistically significant differences ($P > 0.05$) between local, ISA B, and Rose chicken in terms of red blood cell count (RBC), white blood cell count (WBC), haemoglobin concentration (Hb) and packed cell volume (PCV). These results suggest that there is generally similar haematopoietic condition and oxygen-carrying capacity in the types of chicken analyzed.

On the other hand, there were considerable differences (P 0.05) in erythrocyte indices. Mean corpuscular volume (MCV) was significantly greater in local chicken than in ISA Brown and Rose chicken and mean corpuscular haemoglobin (MCH) was significantly more in ISA Brown and Rose chicken. Fluctuations in erythrocyte indices could be due to physiological variations in erythrocyte dimensions and haemoglobin concentration which respond to metabolic rate, nutritional histories, and compensatory responses, and are not necessarily due to genetic origin. Other groups of chickens have been found to have similar variability on erythrocyte indices thus highlighting the need to put haematological values in an appropriate physiological and management context (Scanes, 2009; Braun-Sweazea, 2008).

Biological chemical parameters in serum.

A summary of the results of serum biochemical parameters is provided in Table 2. Serum glucose, total protein and total cholesterol were found to have significant differences among the chicken types (P 0.05). The serum glucose and cholesterol levels were high in the local chickens compared to ISA -Brown and Rose chicken and the highest total protein concentration was observed in Rose chickens.

Another unique pattern of glucose regulation in avian species is the presence of a high level of glucose rather than mammals because of the disparities in insulin sensitivity and endocrine regulation (Braun 2008). To this end, the high glucose levels in the local chickens can be linked with changes in metabolic status or prevailing feeding conditions and not to be genetically determined. Cholesterol has a key role in the lipid metabolism of the avian, hepatic production and transport of cholesterol is the key to the growth and yolk production in laying hens (Naber 1976). Serum cholesterol variation among different types of chickens can thus be associated with a variation in the metabolic activity and lipid utilization.

The measured changes in the serum total protein content are consistent with the available literature indicating that the concentration of serum proteins may vary according to the type of chicken and types of production because of the difference in the growth rate, protein turnover, and physiological demand (Scenes, 2009; Board et al., 2018). Such findings underscore the fact that population-specific reference values should be used to interpret biochemical profiles.

The carcass and the edible organs.

Table 3 shows the effect of the type of chicken on the carcass characteristics and the mass of edible organs. The weight of the carcass also differed among the types of chicken with Rose chicken having lower weight of the carcass compared to local and ISA 1/8 Brown chicken (P 0.05). The weights of the breast, thigh and wing of the ISA B chicken were significantly higher than those of the other types of chicken and this implies that there is a disparity in the distribution of the carcass cut.

These findings are in line with the established effects of the selection history on carcass composition. The outcome of intensive selection on broiler and layer traits on particular production attributes has created an uneven distribution of muscles and growth patterns compared to less-selected local chickens (Havenstein et al., 2003b, and Tavarez and Solis de los Santos, 2016).

Chickens reared locally had significantly higher gizzard weights than the ISA 927Brown and Rose but no differences were found in the liver weights. The development of gizzards has been reported in relation to being diet-based, whereby as diet changes to a more coarse one and mechanical digestion is improved, the size of the gizzards also increases (Svihus 2011). The difference in the size of the gizzard between local and non-local chickens can therefore be seen as an adaptation to historical feeding patterns and not necessarily a difference between types of chicken.

Correlation analysis

Table 4 shows the Pearson correlation coefficients of the chosen traits. Breast and thigh weights showed high positive correlation ($r = 1.905$, $P < 0.01$), which indicated that there was an integrated development of the major muscle groups. This correlation is expected, because the accretion of muscles, at cross-sections of the carcass in growing chickens, is generally proportional (Havenstein et al., 2003b).

Moreover, the serum glucose concentration and total cholesterol levels were significantly correlated in a positive way ($r = 0.829$, $P = 0.05$). The correlation is due to the intimal metabolic interaction between carbohydrate metabolism and lipid metabolism in the avian species with the levels of hepatic glucose connected to the production of lipid and cholesterol (Braun & Sweazea, 2008; Naber, 1976). These correlations should be taken with caution since the sample size is small and the results are thus not final but tentative.

Integrated interpretation

In an overall sense, it can be seen that there are quantifiable variations in hematological parameters, serum biochemistry, and carcass characteristics between local, layer, and broiler type chicken. These differences are probably due to the differences in metabolic condition, selective breeding background, previous management circumstances, and not to strict genetic control. Similar findings have been provided by previous comparative studies analyzing the combined effects of the physiological, nutritional, and selection variables on poultry traits (Tallentire et al., 2016; Tavarrez and Solis de los Santos, 2016).

The current results offer a comparative background of data and significance of poultry type and physiological background in the interpretation of the hematological and carcass profiles. These observations should be triangulated by larger and standardized population-based studies to ensure that the patterns observed are not artefactual as well as get a clearer picture of the underlying processes.

Table 1. Hematological traits in three chicken types (Mean ± SE)

Different letters within a column indicate significant differences (Duncan, 1955; P ≤ 0.05).

Treatment	RBC	WBC	Hb	PCV	MCV	MCH
T1	2.76 ± 0.140	80.75 ± 3.06	15.40 ± 0.701	45.17 ± 1.12	132.83 ± 2.89 a	36.63 ± 1.53 b
T2	2.43 ± 0.24	86.08 ± 7.55	12.73 ± 1.54	41.41 ± 7.84	122.03 ± 0.98 b	56.30 ± 0.70 a
T3	2.45 ± 0.19	96.44 ± 7.84	12.77 ± 0.95	39.43 ± 3.07	122.00 ± 1.15 b	55.00 ± 0.57 a

Interpretation note: In this dataset, significance marking is shown only for MCV and MCH; therefore, RBC/WBC/Hb/PCV are interpreted as not significantly different among treatments under the applied mean-separation criterion.

Table 2. Serum glucose, total protein, and total cholesterol (Mean ± SE)

Different letters within a column indicate significant differences (Duncan, 1955; P ≤ 0.05).

Treatment	Glucose	Total protein	Total cholesterol
T1	237.53 ± 24.90 a	4.23 ± 1.12 b	163 ± 11.11 a
T2	151.33 ± 13.38 b	3.19 ± 0.10 c	109 ± 15.09 b
T3	138.00 ± 1.732 b	5.26 ± 0.008 a	100 ± 9.23 b

Table 3. Carcass components and edible organs (Mean ± SE)

Different letters within a column indicate significant differences (Duncan, 1955; P ≤ 0.05).

Chicken type	Carcass weight (g)	Thigh (g)	Breast (g)	Wing (g)	Liver (g)	Heart (g)	Gizzard (g)
T1 (Local)	1676 a	148 b	208 b	58 b	30.51	5.12 c	38.99 a
T2 (ISA Brown)	1562 a	188 a	419 a	77 a	37.76	10.42 a	30.10 b
T3 (Rose)	1183 b	131 b	198 b	68 ab	39.28	7.36 b	23.80 b

Table 4. Pearson correlation coefficients among selected traits

* P < 0.05, ** P < 0.01

Trait	Glucose	Cholesterol	Weight.thigh	Weight.chest
Glucose	1	0.829*	-0.208	-0.416
Cholesterol	0.829*	1	-0.187	0.265
Weight.thigh	-0.208	-0.187	1	0.905**
Weight.chest	-0.416	0.265	0.905**	1

Conclusions

As mentioned in the current study, it was observed that a difference in hematological values, serum biochemical parameters, and carcass characteristics could be measured between two local breeds of chickens, the ISA Brown and the Rose chicken breeds. The erythrocyte indices, serum glucose, total protein, cholesterol, and distributions of carcass cuts and gizzard weight were significantly different, and this demonstrated the difference between the physiological and metabolic profiles of the evaluated types of chicken.

These differences can likely be explained by the differences in the evolutionary histories, metabolic needs, and the previous conditions of management of each breed, as opposed to hereditary factors. The high positive correlations between the weights of the breast and thigh, and the serum glucose and cholesterol levels of these populations of avian birds indicate that there is an integrated nature of the metabolic and growth processes within these communities. Lastly, the avian hematology as well as carcass traits comparative analysis are to be evaluated in the framework of particular types of chicken and physiological contexts. The results give background data and emphasize the necessity of further studies with bigger, homogenous cohorts to establish the physiological variance in particular chicken genotype better.

Practical Implications

The following suggestions are suggested: Blood profiles can be interpreted in the light of gnotype because the clinical physiological values in several ethnic groups can be different (Cummings et al., 2025). The measured differences between glucose and cholesterol concentrations have highlighted that the use of metabolic profiling is necessary to compare different avian taxa since there is a difference in glycemic regulation (Quattrone et al., 2025) and lipid metabolism (Naber, 1976).

• The variation of gizzard weight indicates that nutritional structure and intestinal fitness should be a consideration between genotypes (Svihus, 2011).

The physiological and behavioral differences attributed to a strong genetic determinant of traits (Tavárez & Solis de los Santos, 2016) or a breeding strategy, which affects expression of the traits.

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