Journal of Sustainable Veterinary & Allied Sciences
P-ISSN-2695-2661 e-ISSN: 2811-1346
JoSVAS 2023 December Vol. 5 Issue 2: -55-60

Michael Okpara University of Agriculture, Umudike, Nigeria
Original Research

Evaluations of the effect of genetic variations on serum renal function markers, bilirubin and lipid profile of laying domestic fowls

[1]Nweze E.C, [1]Ukweni I.A, [2]Agbo C.C, [1]Ukwueze I.J & [1]Odo B.C

[1]*Department of Veterinary Physiology and Pharmacology, Michael Okpara University of Agriculture, Umudike, Abia State,*
[2]*Department of Agricultural Engineering, Nnamdi Azikiwe University Awka, Anambra State, Nigeria*

*Corresponding author: ernest.nweze@yahoo.com; Tel: +2348066336466

ABSTRACT

A total of 16, 18 weeks old chickens with mean weight 1.99±0.12 kg (1.85-2.30kg) were used to compare the serum biochemical characteristics of four chicken genotypes (breeds/strains) from south-eastern part of Nigeria. The chickens were grouped based on their genotypes (breeds/strain) in a Completely Randomized Design for the four-week study. The genotypes (breeds) considered were Black Australorp (BA), Isa Brown (IB), Noiler (NOI) and Local chicken (LC) at 4 chickens per genotype. At the end of the experiment, four (4) birds per genotype were drawn and their blood samples analysed for serum biochemical studies. The mean total cholesterol (TC), triaceylglycerol (TAG) and very low density lipoprotein cholesterol (VLDL-C) concentrations of local chicken (LC) were significantly ($P < 0.05$) higher than the Isa brown (IB) values. Similarly, the mean blood urea nitrogen (BUN) concentrations of LC was significantly ($P < 0.05$) higher than the Noiler value. The mean high density lipoprotein cholesterol (HDL-C) of black Australorp (BA) was significantly ($P < 0.05$) higher than the value of Noiler but showed no significant ($p > 0.05$) difference when compared to the values of IB and LC. There were however no significant ($p > 0.05$) variations in the mean low density lipoprotein cholesterol (LDL-C), total bilirubin, direct bilirubin, indirect bilirubin and creatinine concentrations among all the breeds investigated. In conclusion, the results obtained in this study will be helpful in creating a baseline data on biochemical profiles of indigenous and exotic chicken breeds in Nigeria which in turn can be used for assessing the health status of these birds, improving desirable breeds/traits and designing appropriate breeding strategies for indigenous poultry birds in the country..

Keywords: Bilirubin, domestic fowls, genetic variations, lipids, renal function markers

INTRODUCTION

The assessment of the nutritional and health status in livestock can be made by determining certain blood metabolite concentrations (Ndlova *et al.,* 2007). The physiological status of an animal, breed, nutrition, season and age may affect the concentration of blood biochemical parameters. Blood plays an important role in the transportation of nutrients, metabolic waste products and gases around the body (Zhou *et al.*,1999) and represents a means of assessing clinical and nutritional health status of animals (Olorode & Longe, 2000). The haemato-biochemical profiles are most commonly used in nutritional studies for chickens (Adeyemi*et al.,* 2000) and other birds like pigeon (Pavlak*et al.,* 2005), guinea fowl (Onyeanusi, 2007), bronze turkey (Schmidt *et al.,* 2009) and Japanese quail (Arora, 2010). It has been shown that data from blood profiles could be exploited in the improvement of chicken stocks (Ladokun*et al.,* 2008). In addition, blood parameters help in the diagnoses of specific poultry pathologies and might serve as basic knowledge for studies in immunology and comparative avian pathology (Bonadiman *et al.,* 2009).

Studies on Thai native chickens (Koronowicz *et al.,* 2016), naked-neck indigenous chickens of Kashmir (Pampori & Iqbal, 2007), Cobb broilers (Barreiro *et al.,* 2009; Daneshyar *et al.,* 2009) and laying hens (El-Gendy *et al.,* 2011; Yanagita *et al.,* 2011) showed that haemato-biochemical profiles of chickens are correlated with a number of factors such as gender, nutrition, rearing temperature, stocking density and stress conditions.

Total cholesterol is a precursor of steroid hormones and a simultaneously building component of cell membranes (Pavlík *et al.,* 2007; Zhang *et al.,* 2019).

Several factors (sex, breed, physiologic status, nutrition, age, genetics, stress, disease, management system, location and

http://doi.org/10.54328/covm.josvas.2023.129

season) are known to affect haemato-biochemical values in domestic animals (Addass *et al.,* 2010).Various reports have underlined the emerging observation that it may be difficult to formulate a universal biochemical profile for indigenous chickens due to interplay of the aforementioned factors (Daramola *et al.,* 2005; Addass *et al.,* 2010). Much work has not been done on the influence of breed on the serum biochemical values of laying chickens in the tropical zone of Abia State. Therefore,this study was designed to evaluate the effect of breed on the bilirubin levels, renal function markers and lipid profile of laying domestic chickens kept in the tropical eco-zone of Nigeria.

MATERIALS AND METHODS

EXPERIMENTAL ANIMALS

The study was carried out in the Poultry Unit of the Department of Animal Health and Production, College of Veterinary Medicine Teaching and Research Farm, Michael Okpara University of Agriculture, Umudike. Sixteen (16) 18-week old apparently healthy Black Australorp (BA), Noiler, Isa brown (IB) and local chicken (LC) of mean weight 1.99±0.12 kg (1.85-2.30kg) sourced from a poultry farm in the Southern Nigeria were used for this study. The birds (chickens) were acclimatized for three weeks before the commencement of this study. Appropriate routine prophylactic medications were given as and when due or when necessary to ensure the optimal health of the experimental chickens.The birds were fed twice daily with commercial layers mash throughout the period of the study. Clean fresh cool water was provided *ad libitum* for the chickens throughout the period of the study. Ethical approval for this study was obtained from the Ethical Committee of College of Veterinary Medicine, Michael Okpara University of Agriculture, Umudike, Nigeria (MOUAU/CVM/REC/202216).

EXPERIMENTAL DESIGN

Sixteen (16) adult chickens were randomly assigned to four treatment groups (A to D) according to their genotypes of four (4) chickens per group in a completely randomized design (CRD). Group A: Black Australorp (BA), Group B: Isa Brown (IB), Group C: Noiler (NOI) and Group D: local chicken (LC). The birds were identified with tag letters thus; A_{1-4}, B_{1-4}, C_{1-4} and D_{1-4} representing groups A-D and they were kept individually in separate cages and were maintained in these separate cages throughout the period of the study. Five milliliter (5ml) of blood samples were collected from the wing veins of the experimental birds (BA, IB, NOI and LC) and dispensed into plain sample bottles and allowed to clot in a slanting position and centrifuged at 2,500 RPM for 5minutes (Hrubec*et al.,* 2004). The resulting sera were aspirated, stored at -20 °C and used to determine serum blood urea nitrogen (BUN) (Burtis & Ashwood, 1999), creatinine (Newman & Price, 1999), total bilirubin (Cheesbrough, 1991), direct bilirubin (Tietz, 1976), total cholesterol (TC) (Artiss & Zak, 1997), triaceylglycerols (TAG) (Rifai*et al.,* 1999) and high density lipoprotein cholesterol (HDL-C) concentrations (Rifai & Warnick, 1994). Indirect bilirubin concentration was obtained by subtracting direct bilirubin from total bilirubin. Serum low density lipoprotein cholesterol (LDL-C) was also calculated using Friedewald's equation (Friedewald*et al*., 1972).

LDL-C = [TC – {HDL-C+ (TAG/5)}]

Serum very low density lipoprotein cholesterol (VLDL-C) concentration was calculated by multiplying TAG by 0.2 (Wilson *et al.,* 1981; Kenneth, 2001).

VLDL = 0.2 x TAG (where TAG is triacelyglycerols).

DATA ANALYSIS

The data collected for each of the serum renal function markers, bilirubin and lipid parameters from the different genotypes were presented as mean ± SEM and subjected to One Way Analysis of Variance (ANOVA) using Statistical Package for Social Sciences (SPSS) version 20.0 (SPSS, 2012). Variations in means were separated using Duncan's New Multiple Range Test (Steel & Torrie, 2006; SAS, 2010). Probability values ≤ 0.05 were considered significant.

RESULTS

The mean total cholesterol (TC), triaceylglycerol (TAG) and very low density lipoprotein cholesterol (VLDL-C) concentrations of local chicken (LC) were significantly ($P < 0.05$) higher than the Isa brown (IB) value. Similarly, the mean blood urea nitrogen (BUN) concentrations of LC was significantly ($P < 0.05$) higher than the Noiler (NOI) value.

Table I: The mean serum bilirubin levels and kidney function markers of laying chickens as influenced by genotypes (breeds).Values are expressed as means ± SEM in the table

Parameters (mg/dl)	Treatments (Genotypes)			
	BA	IB	NOI	LC
Total Bilirubin	0.33±0.02	0.32±0.01	0.33±0.01	0.38±0.04
Direct Bilirubin	0.14±0.02	0.14±0.03	0.16±0.04	0.12±0.02
Indirect Bilirubin	0.19±0.02	0.18±0.04	0.17±0.03	0.26±0.04
Urea (BUN)	12.60±,0.51^{ab}	11.11±0.35^{ab}	9.77±0.94^{a}	13.18±1.39^{b}
Creatinine (SCr)	0.35±0.08	0.31±0.03	0.32±0.03	0.38±0.06

^{ab}Mean values in the same row with no similar superscripts are significantly different ($P<0.05$)
BA = Black Australorp; IB = Isa Brown; NOI = Noiler; LC = Local Chicken

The mean high density lipoprotein cholesterol (HDL-C) of Black Australorp (BA) was significantly (P<0.05) higher than the value of Noiler but showed no significant (p>0.05) difference when compared to the values of IB and LC. There was however no significant (p>0.05) variations in the mean low density lipoprotein cholesterol (LDL-C), total bilirubin, direct bilirubin, indirect bilirubin and creatinine concentrations among all the breeds investigated.

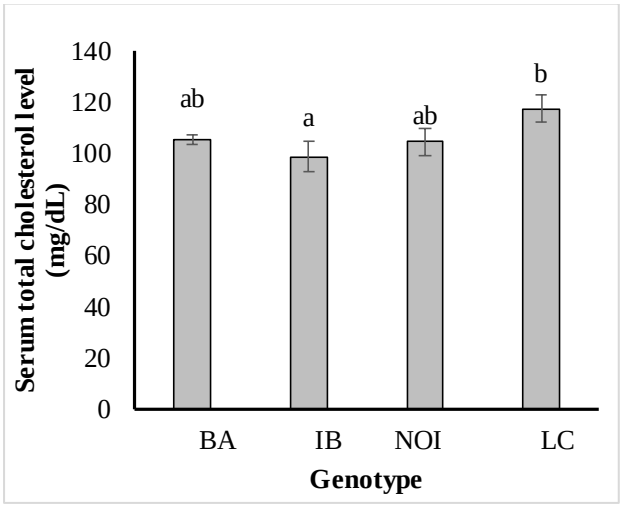

Figure I: The mean serum total cholesterol concentration of laying chickens as influenced by genotypes (breeds). Values are expressed as means ± SEM. Values with different superscripts are statistically (p<0.05) different. BA = Black Australorp; IB = Isa Brown; NOI = Noiler; LC = Local Chicken

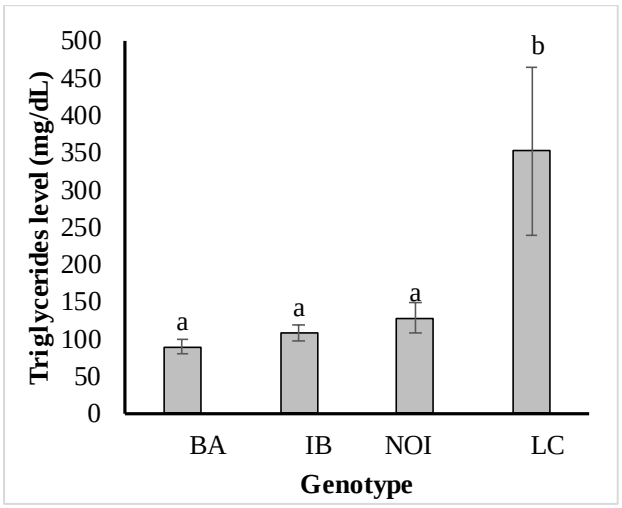

Figure II: The mean serum triglycerides (TAG) concentration of laying chickens as influenced by genotypes (breeds). Values are expressed as means ± SEM. Values with different superscripts are statistically (p<0.05) different

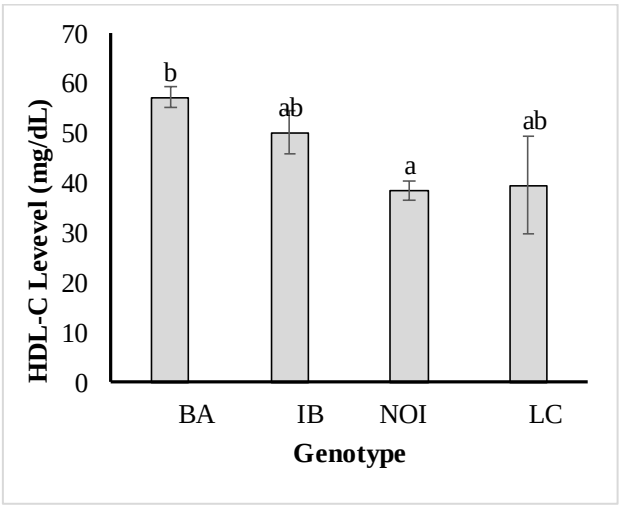

Figure III: The mean serum high density lipoprotein cholesterol (HDL-C) concentration of laying chickens as influenced by genotypes (breeds). Values are expressed as means ± SEM. Values with different superscripts are statistically (p<0.05) different

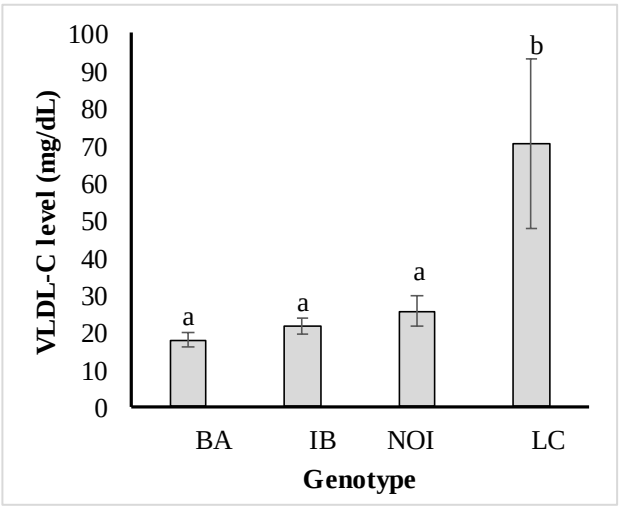

Figure IV: The mean serum very low density lipoprotein cholesterol (VLDL-C) concentration of laying chickens as influenced by genotypes (breeds). Values are expressed as means ± SEM. Values with different superscripts are statistically (p<0.05) different.

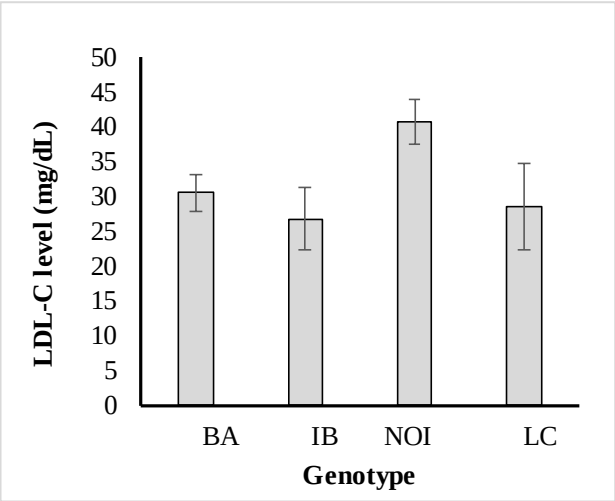

Figure V: The mean serum low density lipoprotein cholesterol (LDL-C) concentration of laying chickens as influenced by genotypes (breeds). Values are expressed as means ± SEM. Values with different superscripts are statistically ($p<0.05$) different.

DISCUSSION

The results of the effect of genetic variations on the kidney function markers and bilirubin profiles of laying chickens are presented in Table I while the results of the effect of genetic variations on the lipid profile of laying chickens are shown in Figures I-V. Creatinine and urea are often used as indicators of renal function in mammals with elevations in both parameters above the reference ranges being seen in the latter stages of renal failure (Jenkins, 2008; Kaneko *et al.*, 2008). The urea values obtained in this present study were higher than the range of 0.48 to 0.63 mg/dl reported by Okpe & Abdulfatai (2022) for broiler chickens. Also, the blood urea nitrogen (BUN) values obtained in this present study were higher than the range of 5.56±0.29 to 6.63±0.31 mg/dl reported by Nweze (2021) in Duroc sows. However, the urea values obtained in this study were within the range of 10.20 to 29.74 mg/dl reported by Egu (2017) in Harco cocks except for the urea value of Noiler chickens which falls below this range. This disparity in urea values in previous works compared to this present study may be attributed to differences in breed and nutritional status of the birds/animals used for the study, management, climatic factors, among others. It has been observed that serum urea concentration depends on both the quantity and quality of protein supplied in the diets (Iheukwumere & Herbert, 2002).

The serum creatinine values obtained in this study were below the ranges of 1-2 mg/dl reported for birds by Banerjee (2007), 18.00-18.50 mg/100ml reported by Iheukwumere *et al.* (2002) in broiler chickens and 2.46±0.09 to 2.86±0.28 mg/dl reported in Duroc sows (Nweze, 2021). Creatinine measurement is used exclusively in the assessment of kidney function. The rate of production of creatinine is constant and elevations of plasma creatinine are indicative of under excretion suggesting kidney impairment. Stockham & Scott (2007) reported also that creatinine along with blood urea nitrogen concentration is an excellent indicator of protein metabolism and kidney function.

Cholesterol and triaceylglycerol in this present study showed significant breed variations. The cholesterol values obtained in this study were within the normal physiological range of 52-148 mg/dl reported by Banerjee (2007) for birds. This implies that the chickens used in this study may not face the risk of myocardial infarction usually associated with high blood cholesterol concentrations or emaciation due to low serum cholesterol concentrations (Frandson, 2002). A decrease in the plasma cholesterol concentration has been reported to result in reduction in the plasma concentrations of insulin-like growth factor and progesterone and consequently delayed or inhibited ovulation (Maciel*et al.*, 2010).

CONCLUSION

Genotypic variations cause statistically significant alterations in the blood urea nitrogen and lipid profile of domestic chickens used in this study. However, the magnitude of the observed decline in some serum metabolites is sufficiently great to suggest that breed of the chickens should be taken into consideration in setting routine upper reference limits for these measurements.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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