

Review Article

Sexual Dimorphism in Growth Traits, blood parameters and Protein Polymorphism of Adult Helmeted Guinea fowl (*Numidia meleagris*) from Kwara State, Nigeria

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Abstract

Phenotypic and biochemical evaluations are useful tools for genetic improvement and continuous breeding of available poultry species. This study examined one hundred and twenty (120) males and females adult helmeted Guinea fowls from Kwara State, Nigeria, using phenotypic traits, blood profiles and haemoglobin polymorphism. The results revealed that males had significantly ($p < 0.05$) higher bodyweight than their female counterparts, and no significant ($p > 0.05$) differences occurred in the values obtained for wing, keel and beak length between males and females. The values obtained for all the blood parameters examined in this study were within the normal range, but female Guinea fowls studied had higher ($p < 0.05$) total cholesterol than their male counterparts (220.45mg/dL vs. 193.88mg/dL). The haemoglobin types (AA), (AB) and (BB) were distributed at the rate of 25.00%, 62.50% and 12.50% in male guinea fowl. There was no HbAA type in the female studied, but HbAB and HbBB were distributed at the rate of 75% and 25%, respectively. This study showed notable variation in body weight, some morphometric body parameters, blood profiles and haemoglobin polymorphism in the Nigerian Guinea fowl studied and suggests phenotypic and biochemical selection of Nigerian Guinea fowls in any programme designed for their genetic improvement as it will facilitate their optimum production and alleviate the shortage of animal protein for the teeming population.

Keywords: Guinea fowl, Growth traits, Blood profile, Haemoglobin polymorphism, Sexual dimorphism.

Introduction

In developing countries, the fastest-growing subsector of the livestock industries is poultry production and yet less attention is given to the local types that are hardy, resistance to diseases and produce game flavoured meat because of their low production status. In Nigeria, local poultry types account for about 80% of the poultry production and are majorly reared at the backyard for the production of household egg and meat (Yakubu et al., 2020; Sola-Ojo et al., 2021).

The helmeted guinea fowl (*Numida meleagris*) is one of the abundant terrestrial birds that are reared in the backyard of poultry lovers for the provision of animal protein in terms of egg and meat as well as source of income, and provisions of manure for backyard farming. Guinea fowl contributes proportionately to food security and livelihood among rural dwellers. In the year 2012, National Bureau of Statistics (NBS) stated that the population of Guinea fowl is ranked second with a value of 16, 976, 907 compared to chickens with a population of 101,676,710. Guinea fowl has good scavenging ability for grains and insect and they are disease resistant, their meat is highly valued in Nigeria because of its characteristics lean nature with less fat, game flavour, high dry matter and protein content (Musumdire et al., 2017; Sola-Ojo et al., 2021).

In livestock improvement and breeding, phenotypic characterization is useful for identification and classification, especially among and between species which is usually the first step in designing an appropriate selection and breeding programme (Sola-Ojo et al., 2020a). Blood parameters evaluation are useful in clinical assessment and they also serve as markers for selection of good breeding stock (Adedibu et al., 2014; Penkov et al., 2019). The use of blood protein polymorphism has gone a long way in genetic differentiation among populations for characterization and it is also an important step in any programmed designed improvement of local livestock's population (Oguntunji et al., 2014; Sola-Ojo et al., 2020).

In Nigeria, it is critical to characterize guinea fowl because it has been reported that there are no pure genotypes of Guinea fowl and they have not been bred selectively (Shoyombo et al., 2021). Therefore, this study was designed to evaluate adult male and female Nigerian helmeted Guinea fowl from Kwara state through the use of growth traits, blood parameters and hemoglobin polymorphism.

Materials and Methods

Description of the Study Area and Management of Experimental Birds

Kwara state is located in the North Central Geo-political zone of Nigeria at 8.4799° N, 4.5418°E as shown in Figure 1.0. (KWSG, 2017).

One hundred and twenty (120) Adult helmeted Guinea fowls (60 males and 60 females) were purchased from major poultry markets, Kwara State and taken to a private farm (Fair and Firm Farm Int'l Limited,

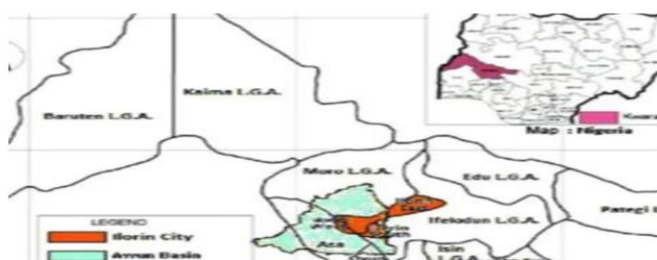


Figure 1.0. Map of Kwara State Nigeria

Tanke, Oke-Odo, Ilorin, Kwara State) for acclimatization and data collection. On arrival at the farm, they were given anti-stress, broad-spectrum antibiotics and quarantined for five days for effective monitoring before data collection. The Guinea fowls were fed commercial layers' diets (17% crude protein and 2700kcal/kg Metabolizable Energy and also provided with potable water *ad libitum* during the period of data collection.

Data Collection

Measurement of Quantitative Body Parameters

Body weight and nine (9) other morphometric body parameters were measured from the adult guinea fowl studied [body length (BDL), keel length (KL), shank length (SL), body height (BH), beak length (BKL) drumstick length (DL), thigh length (TL), wing length (WL), body girth (BG)]. The body weight of an individual bird was determined by placing each Guinea fowl on the loading pan of the Mettler Toledo® top loading scale to the nearest gram, while the linear body measurements were done as described by Sola-Ojo and Ayorinde (2009) using a measuring tape (cm).

Determination of Blood parameters

Five milliliters (5mls) of blood were collected from 20 adult Guinea fowls (10 males and 10 females and labelled according to sex. The blood was collected through brachial venipuncture and carefully transferred into with EDTA bottle for haematological assay, plain bottles were used to collect the blood meant for serum determination, while glucose bottles were used for the blood glucose determination. Blood samples for haemoglobin polymorphism determination were collected from the one hundred twenty (120) population of Guinea fowl sampled and kept in an EDTA bottle before the cellulose acetate electrophoresis procedure. The blood sample tubes were immediately transported to the Central Research Laboratory, Ilorin, Kwara State, Nigeria and a Veterinary Analyser (Veterinary Analyzer, DR-

3125 plus Model, Diatek, India) was used to determine haematological parameters, while the procedures of Randox R were used for Serum and Glucose determination.

Determination of Haemoglobin Polymorphism

One ml of the whole blood was placed in a centrifuge tube that was labelled according to the identification tag given to each guinea fowl sampled based on their sex for haemoglobin typing using the cellulose acetate electrophoresis procedure. 10-15 microliter of cold 0.155 M sodium chloride solution was added to wash the blood, and the sample was centrifuged.

A Gene buffer (DANSUTECH Genotype Buffer) containing Tris EDTA and Boric Acid (Manufactured by Dansutech Resources Nig. Enterprises) was prepared by dilution with 1000ml of distilled water. Cellulose Acetate paper strip was soaked in the Buffer for 30 minutes and bloated with filter paper to remove excess buffer; 0.1 µl of the haemolysed blood was carefully loaded to the acetate paper and placed on the bridge in a humidified electrophoresis tank that has been connected to a power supply (Model DY-300 for Electrophoresis) and set to run for 15 minutes at 300 volts. The sample end was directly placed at the anode point, and the movement of the protein type towards the cathode was allowed for 15 minutes, after which the acetate paper was removed with forceps, soaked in Ponceau S solution for 5 minutes for band staining. The stained band is then washed in glacial acetic acid solution for 5 minutes and gently stirred in 95% absolute methanol for clearer observation of the band, as described by Salako and Ige (2006) and Sola-Ojo et al. (2021) for accurate band scoring.

The band was scored according to the speed of their movement as follows:

A single faster band as AA Homozygote

A single slower band as BB Homozygote

A double band containing both faster and slower bands as AB Heterozygote.

Statistical Analysis

Data collected from quantitative traits and blood parameters were subjected to the General Linear Model (GLM) procedure of variance analysis (ANOVA) using the model:

$$Y_{ij} = \mu + a_i + e_{ij}$$

Where: Y_{ij} = Overall observations;

μ = Overall mean;

a_i = sex effects;

e_{ij} = random experimental error.

Significant differences among means were compared using the Duncan Multiple Range Test (Duncan, 1955) and the frequency of distribution of haemoglobin types was determined using Popgen 1.32 (Yeh et al., 1999).

Results

A low coefficient of variation (7.14 to 21.11) was obtained for body weight and other morphometric parameters measured for the male and female Guinea fowl studied (Table 1). However, there were significant ($p < 0.05$) sex effects with 30.53% variations in the value obtained for bodyweight of males compared to that of females. Morphometric body parameters such as body length, body girth, body height, beak length, shank length, drumstick length, wing length, and thigh length had significantly ($p < 0.05$) higher values in males than females, while keel length value was not significantly ($p > 0.05$) different.

Table 1. Effects of sex on growth traits in Nigerian Adult Guinea fowl (*Numida meleagris*) from Kwara State.

	Male			Female		
Growth Parameters	(n=60) Mean	SD	COV	(n=60) Mean	SD	COV
BW (g)	1310.00 ^a	0.19	14.61	910.00 ^b	0.18	19.78
BDL(cm)	41.71 ^a	2.88	7.43	38.12 ^b	2.72	7.14
BG (cm)	32.00 ^a	2.38	7.44	25.73 ^b	2.03	7.88
BH (cm)	30.43 ^a	2.23	7.33	27.85 ^b	2.02	7.25
KL (cm)	9.21	1.95	21.11	9.18	1.42	15.46
BKL (cm)	2.84 ^a	0.46	16.19	2.61 ^b	0.30	11.49
SL (cm)	8.57 ^a	0.98	11.44	7.51 ^b	0.60	7.99
WL (cm)	16.12 ^a	2.30	14.50	15.86 ^b	1.70	10.54

DL (cm)	11.29 ^a	1.15	10.18	10.74 ^b	0.89	8.29
TL (cm)	10.07 ^a	1.61	15.98	9.49 ^b	1.41	14.86

Means with different superscripts on the same row are significantly different.

BW: body weight, BDL: body length, BG: body girth, BH: body height, KL: keel length, BKL: Beak length, SL: Shank length, WL: wing length, DL: drumstick length, TL: thigh length.

The results obtained for blood parameters as indicated in Table 2. shows significant ($p < 0.05$) variations in white blood cells, packed cell volume, lymphocytes, red blood cells, mean corpuscular haemoglobin concentration, platelets, glucose, total cholesterol, triglyceride, high-density lipoprotein, cholesterol or low-density lipoprotein-cholesterol between males and females. However, there was no significant ($p > 0.05$) variation in the value obtained from haemoglobin and red blood cells. The values obtained for WBC, LYM, MCHC, PLT, T-CHOL, TRIG, and LDL-C in females were higher than those obtained for males, while male guinea fowl had the highest values for PCV and HDL-C. From this study, it was recorded that the total cholesterol and low-density lipoprotein-cholesterol were significantly ($p < 0.05$) higher in females than the values obtained for males (220.45 vs. 193.88, and 161.58 vs. 148.88).

Table 2. Effects of Sex on Blood Profile of Nigerian Adult Guinea fowl (*Numida meleagris*) from Kwara State.

Blood Parameters	Male	Female
WBC x 10 ⁶ /mm ³	44.00 ^b ±1.00	58.00 ^a ±0.50
P.C.V (%)	38.51 ^a ±0.75	36.35 ^b ±1.25
LYM (%)	52.97 ^b ±2.71	61.13 ^a ±1.91
RBCx10 ⁶ /mm ³	4.13±2.08	3.35±1.32
Hb (%)	11.63±0.29	10.68±0.87
MCHC (%)	13.10 ^b ±1.14	18.17 ^a ±0.41
PLT	230.25 ^b ±19.96	440.19 ^a ±43.14
Glucose (mg/dL)	173.28 ^b ±3.45	162.41 ^b ±4.39
Total cholesterol mg/dL	193.88 ^b ±2.89	220.45 ^a ±7.89
Triglyceride (mg/dL)	147.83 ^b ±1.46	161.57 ^a ±8.90
HDL-C (mg)	44.32 ^a ±0.61	35.81 ^b ±0.88
LDL-C (mg)	148.99 ^b ±12.94	161.58 ^a ±11.85

Means with different superscripts on the same row are significantly different.

WBC: White Blood Cell; PCV: Packed Cell Volume; LYM: Lymphocytes; RBC: Red Blood Cells; HGB: Haemoglobin; MCHC: Mean Corpuscular Haemoglobin Concentration; HDL-C: High-Density Lipoprotein- Cholesterol; LDL-C: Low-Density Lipoprotein- Cholesterol.

Table 3 shows the frequency distribution of haemoglobin polymorphism determined through the process of cellulose acetate electrophoresis. It was observed that there were 25.00%, 62.50% and 12.50% of HbAA, HbAB, and HbBB types, respectively in male Guinea fowls studied. There was no HbAA type among the females, but 75% of the female population had HbAB types, while 25% had HbBB types.

Table 3. Effect of Sex on Haemoglobin polymorphism in Nigerian Adult Guinea fowls (*Numida meleagris*) from Kwara State.

Haemoglobin Polymorphism	Frequency Distribution (%)	
	Male	Female
AA	25.00	0.00
AB	62.50	75.00
BB	12.50	25.00

Discussion

Studies of variations in growth traits, blood parameters and haemoglobin polymorphism have been one of the key factors in understanding the genetic architecture, overall health determination and species characterization as well as genetic diversity, all of which are crucial to species adaptation and survivability. Sola-Ojo and Ayorinde, (2009) and Yakubu et al., (2013) asserted that knowledge of body size and skeletal dimensions in poultry are important tools in the determination of genetic differences between and within populations while Fajemilehin (2010) reported diverse body weights, body girth, wing length, keel length and drumstick length and discovered variations due to sex in twenty-eight (28) week-old grey-breasted helmeted of pearl, ash, lavender and black plumage Nigerian Guinea fowl.

However, the author reported an average range of 950.78g to 980.15g body weight for intensively raised female Guinea fowl and this was higher than 910g obtained for adult females Guinea fowls that were purchased from different markets for this study, and the differences in average body weight valued obtained might be due to system of management of the adult Guinea fowl studied. However, the average body weight values obtained for male adult guinea fowl in this study were within the range of 1300g reported for adult Guinea fowl sampled from Northern Togo by Soara et al. (2020).

Measurement of biochemical parameters concerning sex is a factor that should be considered in the genetic improvement of guinea fowl, as evaluation of blood profiles in diversity study is very important because serum proteins, enzymes and bilirubin have been established as genetic markers in farm animals (Pagot, 1992). The blood parameters obtained here correspond with some values earlier reported for Guinea fowl by some authors. The PCV obtained here was higher in males than that obtained for females (38.50 vs 36.30). The RBC of (4.13 vs. 3.35), Hb (11.63 vs 10.68), and MCHC (13.10 vs. 18.17) obtained in this study correspond with the findings of Adedibu et al. (2014) for adult helmeted Guinea fowls. In this study, the females had higher values for MCHC, PLT, TChol, and LDL than males and the highest value obtained for MCHC in female Guinea fowl from this study corresponds with the values reported by Uko and Ataja, (1996) where significant sex differences in blood parameters were reported for Guinea fowls from North-Western Nigeria. The variations obtained from this study could also be a result of sex influence and different hormone profiles of male and female guinea fowl.

The Guinea fowls evaluated here show significant variation in haemoglobin polymorphism and this corresponds with the findings of Sola-Ojo et al. 2020b where variations in haemoglobin polymorphism were reported for the Nigerian local chickens. The polymorphic nature of the Hb types obtained here corresponds with those reported by Fajemilehin (2014) where the author reported the common occurrence of HbAA and HbAB genotypes in Guinea fowl and this supports corroborate the common occurrence of these genotypes and it could be stated that they are relevant to the survivability and adaptability of Guinea fowl in their natural habitat.

Conclusion

This study shows that variations exist between male and female guinea fowl in all parameters measured. The results obtained for body weight and morphometric body parameters from this study will serve as markers for growth and overall performance, while those obtained for blood parameters will serve as markers for overall health, and that of haemoglobin polymorphism will be an indicator for genetic diversity and survivability of Guinea fowl obtained from the study area. The results will also support any selection programme designed for genetic improvement of helmeted guinea fowl for meat and egg production, and alleviate the shortage of animal protein in Nigeria. The information obtained from this study will aid in programmed selection procedures that are designed for the production of Nigerian Guinea fowl. Further research involving a larger population of adult Nigerian Guinea fowl and their molecular characterization with appropriate markers is recommended for the establishment of genetic diversity of this valuable poultry species.

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Author's Contributions

Sola-Ojo, Adeola and Adedeji conceived and designed the study, Chimezie, Yusuf, Alli, Okukpe, Ajao, Adeshina, Yusuf, Abubakar, Bajomo, Adedeji, Oladipo, and Abayomi-Sule were involved in data collection and review, Sola-Ojo, and Adeola analyzed and interpreted the data, Chimezie and Sola-Ojo wrote the manuscripts while other authors contributed in editing and approved the manuscript.

Ethics

This work was carried out under the ethical approval of the Faculty of Agriculture, University of Ilorin, Ilorin, Kwara State, Nigeria, with approval number FERC/ANPR/2019/102.

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