Influence of Breed and Haemoglobin Variability on Linear Body Measurements and Haematological Traits in Three Strains of Local Chickens in Nigeria

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Research Article

ABSTRACT

This study investigated the influence of breed and haemoglobin variability on linear body measurements and haematological traits in three strains of local chickens in Nigeria. A total of 150 chickens, comprising 50 birds from each strain, were sourced from local poultry breeders and reared under uniform management conditions, ensuring access to feed and water *ad libitum.* Haemoglobin (Hb) variability was determined using standard laboratory procedures. Linear body measurements, including body weight (BW), body length (BL), wing span (WS), shank length (SHL), and drumstick length (DS), were recorded using a graduated tape and weighing scale. Data obtained was subjected to one-way analysis of variance while significant means were seperation using duncan multiple range test using the procedure of SPSS version 27. The results revealed significant variations in body measurements among the three breeds. Naked neck (NN) chickens exhibited the highest body weight (1.20 kg), whereas Frizzled Feathered (FF) chickens had the lowest (0.80 kg). Significant differences ($p < 0.05$) were observed in shank length and chest circumference across breeds. Haematological parameters varied significantly, with normal feathered (NA) chickens having the highest packed cell volume (PCV) of 35.18% compared to NN (16.58%) and FF (28.30%). Hb genotypes also influenced haematological traits, with BB genotypes showing higher PCV (30.64%) and white blood cell counts (11.57) than AA and AB genotypes. The study highlights the impact of genetic variability on morphological and physiological traits, suggesting that haemoglobin polymorphism may serve as an indicator of breed adaptability and productivity in local chickens. Further research is recommended to explore the genetic basis of these variations for improved breeding strategies in indigenous poultry production.

Ethic Approval

Ethical approval for this study was obtained from Department of Animal Science, Faculty of Agriculture, University of Calabar Ethical İnstitutional Animal Care and Use Committee; with approval number UNICAL/AGR/ANS/2024/85.

Nijerya'da Üç Yerel Tavuk Irkında Irk ve Hemoglobin Değişkenliğinin Doğrusal Vücut Ölçümleri ve Hematolojik Özellikler Üzerindeki Etkisi

ÖZ

Bu çalışma, Nijerya'daki üç yerel tavuk ırkında, ırk ve hemoglobin değişkenliğinin doğrusal vücut ölçümleri ve hematolojik özellikler üzerindeki etkisini araştırmak için düzenlenmiştir. Her bir ırktan 50 kanatlı olmak üzere toplam 150 tavuk, yerel kümes hayvanı yetiştiricilerinden sağlanmış, yem ve suya *ad libitum* erişim sağlanarak tekdüze yönetim koşulları altında yetiştirilmiştir. Hemoglobin (Hb) değişkenliği standart laboratuvar prosedürleri kullanılarak belirlenmiştir. Vücut ağırlığı (BW), vücut uzunluğu (BL), kanat açıklığı (WS), incik uzunluğu (SHL) ve baget uzunluğu (DS) dahil olmak üzere doğrusal vücut ölçümleri, dereceli bir şerit ve tartı kullanılarak kaydedilmiştir. Sonuçlar, üç ırk arasında vücut ölçümlerinde önemli farklılıklar olduğunu ortaya koymuştur. Çıplak boyunlu (NN) tavuklar en yüksek vücut ağırlığını (1,20 kg) sergilerken, Kıvırcık Tüylü (FF) tavuklar en düşük ağırlığa (0,80 kg) sahip olmuştur. Irklar arasında bacak uzunluğu ve göğüs çevresinde önemli farklılıklar (p<0,05) gözlenmiştir. Hematolojik parametreler önemli ölçüde değişmiş olup; normal tüylü (NA) tavuklar, NN (%16,58) ve FF (%28,30) ile karşılaştırıldığında %35,18 ile en yüksek paketlenmiş hücre hacmine (PCV) sahip olmuşlardır. Hb genotipleri de hematolojik özellikleri etkilemiş; BB genotipleri, AA ve AB genotiplerinden daha yüksek PCV (%30,64) ve beyaz kan hücresi sayıları (11,57) göstermiştir. Çalışma, genetik çeşitliliğin morfolojik ve fizyolojik özellikler üzerindeki etkisini vurgulayarak, hemoglobin polimorfizminin yerel tavuklarda ırk uyum kabiliyeti ve verimliliğinin bir göstergesi olarak hizmet edebileceğini öne sürmüştür. Yerli kümes hayvanı üretiminde geliştirilmiş üreme stratejileri için bu varyasyonların genetik temellerinin araştırılması amacıyla daha fazla araştırma yapılması önerilmektedir.

Introduction

Poultry production is a critical component of Nigeria's agricultural sector, contributing significantly to food security, employment, and economic growth (Adebambo et al., 2018; Ojo et al., 2019). Local chicken strains are particularly important due to their adaptability to harsh environmental conditions, resistance to endemic diseases, and ability to thrive on minimal nutritional inputs (Yakubu and Salako, 2020). Despite these advantages, their productivity remains relatively low compared to exotic and hybrid breeds. Therefore, understanding the genetic and physiological factors influencing their growth and health parameters is essential for optimizing their performance (Ajayi, 2019).

Breed variations play a crucial role in determining the growth potential, body conformation, and overall fitness of poultry (Oke et al., 2021). Linear body measurements, which include traits such as body weight, body length, shank length, wing span, and keel length, are essential indicators of growth performance and meat yield potential in chickens (Melesse et al., 2019). These traits have been widely used for breed characterization and selection in poultry genetic improvement programs (Yakubu et al., 2021).

However, limited research has been conducted on how breed differences influence these measurements in indigenous Nigerian chicken strains. Another crucial genetic determinant of poultry performance is haemoglobin polymorphism, which influences oxygen transport, metabolic efficiency, and overall physiological adaptation (Udeh et al., 2023). Haemoglobin variability has been reported to significantly affect growth performance, stress tolerance, and immune response in poultry (Egena et al., 2018).

Chickens with different haemoglobin types may exhibit variations in haematological traits, such as packed cell volume (PCV), red blood cell (RBC) count, haemoglobin concentration (Hb), and white blood cell (WBC) count, all of which are key indicators of health and physiological status (Abonyi et al., 2022). Understanding the interplay between breed and haemoglobin variability in relation to these traits can provide insights into the genetic selection of chickens with superior adaptive and productive capabilities. Nigeria is home to three predominant strains of local chickens: the Fulani Ecotype, the Yoruba Ecotype, and the Ibo Ecotype. These strains exhibit notable differences in morphological characteristics, growth rates, and disease resistance (Oluyemi et al., 2023). The variations among these strains suggest that their genetic makeup significantly impacts their phenotypic and physiological attributes. Previous studies have indicated that indigenous chicken strains differ in their growth patterns and adaptive traits (Peters et al., 2020), but there is a paucity of literature on the influence of haemoglobin variability in these local strains.

Haematological traits serve as reliable indicators of health status, immune competence, and physiological adaptation in poultry (Ebegbulem et al., 2021). Parameters such as PCV, RBC, Hb, and WBC counts provide essential information about oxygen-carrying capacity, metabolic activity, and immune response (Eze et al., 2023). Studies have shown that differences in haemoglobin types can affect these blood parameters, influencing the overall fitness and productivity of chickens (Chinedu and Ogah, 2019). This study aims to investigate the influence of breed and haemoglobin variability on linear body measurements and haematological traits in three strains of local chickens in Nigeria.

Material and Methods

Ethical approval for this study was obtained from Department of Animal Science, Faculty of Agriculture, University of Calabar ethical institutional animal care and use committee; with approval number UNICAL/AGR/ANS/2024/85.

Study Location

The study was conducted in Calabar, Cross River State, Nigeria. Calabar is located in the southern part of Nigeria, within the tropical rainforest zone. It is characterized by a humid climate with an annual rainfall range of 2000 mm to 3000 mm and an average temperature of 25–30°C. The area provides a suitable environment for poultry farming due to its warm and humid conditions, which support the growth and performance of local chicken strains (Adebayo et al., 2016; Okonkwo et al., 2018).

Experimental Birds and Management

A total of 150 local chickens with body weight ranges between 800 – 900g were used for the study, comprising 50 birds from each of the three strains. Each group was further subdivided into five replicates of ten birds per replicate in a completely randomized design (CRD) experiment. The chickens were raised under the deep litter system using wood shavings as litter material. The birds were obtained from local poultry breeders and reared under similar management conditions, including access to feed and clean water *ad libitum*. Standard biosecurity measures were maintained to ensure the health and welfare of the birds throughout the study period (Oluyemi and Roberts, 2019; Bello et al., 2020). The table 1 below shows the feed composition provided to the chickens.

Blood Sample Collection and Haemoglobin Determination

Blood samples were collected from each bird via the wing vein using sterile syringes and needles. The blood was immediately transferred into sterilized bottles containing Ethylenediaminetetraacetic Acid (EDTA) as an anticoagulant. The collected samples were subsequently analyzed to determine haemoglobin (Hb) variability using standard laboratory procedures (Smith et al., 2017; Adeyemo et al., 2021).

Table 1. Gross composition of basal diets (%)

Ingredients	%
Maize	33.00
Soybean meal	17.00
Wheat offal	17.00
Maize offal	19.00
Palm kernel cake	7.05
Di-calcium phosphate	1.00
Limestone	5.00
Methionine	0.15
Lysine	0.15
Salt	0.40
Premix	0.25
Total	**100.00**
Calculated values	
Crude Protein (%)	16.53
Metabolizable Energy (Kcal/kg)	2659.50
Crude fibre	5.47
Calcium	2.10

Phenotypic Trait Measurements

The linear body measurements of the chickens were taken using a graduated measuring tape (centimeter) except body weight was measured in kilogram using 5kg weighing scale. The following phenotypic traits were assessed:

Body Weight (BW): Measured using a digital weighing scale and recorded in kilograms (kg).

Body Length (BL): Measured from the tip of the beak to the base of the tail.

Wing Span (WS): Determined by measuring the distance between the tips of both wings when fully extended.

Shank Length (SL): Measured from the hock joint to the tip of the claw.

Drumstick Length (DL): Measured from the knee joint to the hock joint (Eze et al., 2016; Udeh et al., 2023). Each measurement was taken three times, and the average value was recorded to ensure accuracy and consistency in data collection.

Statistical Analysis

The collected data were subjected to one-way analysis of variance using SPSS version 27 to evaluate the influence of breed and haemoglobin variability on linear body measurements and haematological traits. Descriptive statistics, was performed using same statistical software, and significance was determined at a 5% probability level ($p < 0.05$) (Ajayi et al., 2019; Ibrahim and Musa, 2024). Significant means were separated using Duncan multiple range test.

Results and Discussion

Table 2 presents the effect of breed on various linear body measurements, including body weight (BW), body length (BL), shank length (SHL), chest circumference (CC), wing span (WS), and drum stick (DS). The breeds compared are NN, NA, and FF, with standard error of the mean (SEM) provided for each trait. The body weight of the NA breed (1.20 kg) was significantly higher ($p < 0.05$) than that of NN (1.07 kg) and FF (0.80 kg), with the latter having the lowest value. The observed differences in BW across breeds suggest variations in genetic potential, nutritional adaptation, and overall growth performance.

Table 2. Effect of breed on linear body measurements

Parameters	Breeds			SEM
	NN	NA	FF	
BW	1.07[ab]	1.20[a]	0.80[b]	0.07
BL	29.20	28.02	25.90	0.78
SHL	8.98[a]	7.98[ab]	7.08[b]	0.34
CC	26.20[ab]	28.00[a]	24.00[b]	0.74
WS	35.60	34.50	33.60	1.13
DS	14.10	13.06	12.12	0.40

[a,b] = mean with different superscripts on the same row differ significantly @ p<0.05, Body weight (BW), body length (BL), shank length (SHL), chest circumference (CC), wing span (WS), and drum stick (DS), NN=Naked neck, FF=frizzled feathered NF=Normal feathered, SEM=standard error of mean

Studies by Yakubu et al. (2018) and Akinyemi and Salako (2020) have shown that breed differences significantly influence growth traits. Furthermore, Ozoje and Herbert (2016) reported that heavier body weights in certain breeds are linked to better feed conversion efficiency and adaptive traits. Body Length (BL) was highest in NN (29.20 cm), followed by

NA (28.02 cm), and lowest in FF (25.90 cm). This suggests that the NN breed possesses a longer skeletal frame, which may be advantageous in terms of meat production and overall body conformation (Oni et al., 2019). Linear body measurements, including body length, have been linked to productive efficiency and adaptability in different environments (Yakubu, 2017). Shank length (SHL) was significantly different across breeds, with NN (8.98 cm) being the highest, followed by NA (7.98 cm), while FF (7.08 cm) had the lowest value. Differences in shank length could indicate variations in skeletal structure and growth patterns, as highlighted by Peters et al. (2021).

Breeds with higher SHL may have better walking efficiency (Adeolu et al., 2020). Chest Circumference (CC) is a key indicator of body conformation and respiratory capacity. The NA breed had the highest CC (28.00 cm), followed by NN (26.20 cm), while FF recorded the lowest value (24.00 cm). Previous studies (Ogunjimi et al., 2016; Abegunde and Ajayi, 2021) have emphasized that chest circumference is a strong predictor of body weight and meat yield potential in livestock. This suggests that the NA breed might be better suited for meat production due to its broader chest conformation.

Wing span (WS) values were similar across the three breeds, with NN (35.60 cm) being slightly higher than NA (34.50 cm) and FF (33.60 cm). Although not significantly different, this trait is important for estimating overall skeletal development and stature. Similar findings were reported by Musa et al. (2022), indicating that variations in WS are generally breed-dependent and influenced by both genetics and environmental factors. Drum stick (DS) showed a decreasing trend from NN (14.10 cm) to NA (13.06 cm) and FF (12.12 cm). This measurement is often used in morphological differentiation, as it provides insight into the overall body frame (Salako, 2018). The results align with previous reports by Bello et al. (2023), where breeds with longer diagonal lengths were found to exhibit better growth potential and adaptability to extensive production systems.

Table 3 presents the effect of breed on various haematological parameters, including packed cell volume (PCV), red blood cell count (RBC), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), white blood cell count (WBC), neutrophils (NUET), basophils (BASO), eosinophils (EOSI), lymphocytes (LYM), monocytes (MONO), and thrombocytes (THROM). These parameters are essential indicators of health status, immune function, and overall physiological adaptation in animals. Packed Cell Volume (PCV) measures the proportion of red blood cells in the blood and is a key indicator of oxygen-carrying capacity and anaemia status (Akinmoladun et al., 2018). The PCV was highest in the NA breed (35.18%), followed

by FF (28.30%) and NN (16.58%), with significant differences ($p < 0.05$). A higher PCV in NA suggests better oxygen transport efficiency and adaptability to environmental stress, as reported by Yakubu et al. (2017). Lower PCV in NN could indicate a predisposition to anaemia, possibly due to breed-specific metabolic rates or nutritional deficiencies (Olugbemi et al., 2020). Red Blood Cell Count (RBC) values followed a similar trend, with NA ($2.61 \times 10^6/\mu L$) having the highest count, followed by FF ($2.07 \times 10^6/\mu L$) and NN ($1.39 \times 10^6/\mu L$) although not significantly different. RBCs play a critical role in oxygen transport, and variations among breeds may be due to genetic factors, environmental adaptation, and nutritional differences (Musa et al., 2022). Higher RBC levels in NA may contribute to better stamina and resilience in harsh climates, as supported by Bello et al. (2023).

Mean Corpuscular Volume (MCV) is an indicator of the average size of red blood cells, with values highest in FF (137.84 fL), followed by NA (134.62 fL) and NN (110.56 fL). Higher MCV in FF suggests macrocytosis, which could be linked to breed-specific haemoglobin synthesis patterns (Adeyemi et al., 2021). MCV is influenced by genetics, nutrition, and disease status (Habibu et al., 2017). Mean Corpuscular Haemoglobin (MCH) represents the average amount of haemoglobin per red blood cell. The FF breed had the highest MCH (51.66 pg), closely followed by NA (50.78 pg) and NN (38.90 pg). This aligns with findings by Peters et al. (2020), who reported that breeds with higher MCH tend to have better haemoglobin efficiency and oxygen-carrying capacity. Lower MCH in NN suggests potential anaemic tendencies, possibly due to lower haemoglobin synthesis (Adebayo and Ojo, 2017).

Mean Corpuscular Haemoglobin Concentration (MCHC) values were highest in FF (37.90 g/dL), followed by NA (37.74 g/dL) and NN (28.24 g/dL). This parameter reflects the concentration of haemoglobin in red blood cells, which influences oxygen transport and metabolic efficiency. The higher MCHC in FF and NA suggests these breeds have a superior oxygen-carrying capacity, making them more suited for intensive production systems (Oni et al., 2019). White Blood Cell Count (WBC) is a crucial indicator of immune function. NA had the highest WBC count ($13.60 \times 10^3/\mu L$), followed by FF ($9.90 \times 10^3/\mu L$) and NN ($5.92 \times 10^3/\mu L$). Higher WBC values in NA indicate stronger immune competence, which may enhance disease resistance (Abegunde and Salako, 2022). Lower WBC in NN suggests a weaker immune response, which could make them more susceptible to infections (Yakubu et al., 2021).

Table 3. Effect of breed on haematological parameters

Parameters	Breeds			SEM
	NN	NA	FF	
PCV	16.58[b]	35.18[a]	28.30[ab]	3.55
RBC	1.39	2.61	2.07	0.24
MCV	110.56	134.62	137.84	9.20
MCH	38.90	50.78	51.66	3.42
MCHC	28.24	37.74	37.90	2.52
WBC	5.92	13.60	9.90	1.58
NUET	2.10	2.90	4.08	0.75
BASO	0.12	0.12	0.52	0.12
EOSI	0.12	0.28	0.84	0.17
LYM	38.50	56.70	74.56	12.15
MONO	0.00	0.00	1.20	0.40
THROM	5.76	10.20	29.20	5.51

PCV=packed cell volume, RBC=red blood cell count, MCV=mean corpuscular volume, MCH= mean corpuscular haemoglobin, WBC= white blood cell count, NUET=Neutrophils, BASO=Basophils EOSI=Eosinophils, LYM=Lymphocytes, MONO=Monocytes, THROM=Thrombocytes, genotypes=(AA, BB, AB), FF=frizzled feathered NN=Normal feathered, SEM=standard error of mean

Neutrophils (NUET) play a key role in innate immunity by combating infections. FF had the highest neutrophil count (4.08 × 10^3/µL), followed by NA (2.90 × 10^3/µL) and NN (2.10 × 10^3/µL). This is in line with studies by Ojo et al. (2018), which suggest that breeds with higher neutrophil counts are better equipped to fight bacterial infections. Basophils (BASO) are involved in inflammatory responses. FF had the highest basophil count (0.52 × 10^3/µL), while NN and NA had similar values (0.12 × 10^3/µL). This suggests that FF may have a stronger allergic or inflammatory response potential (Akinyemi et al., 2020). Eosinophils (EOSI) are associated with allergic reactions and parasitic infections. FF had the highest eosinophil count (0.84 × 10^3/µL), while NA (0.28 × 10^3/µL) and NN (0.12 × 10^3/µL) had lower values. This may indicate a higher immune response to parasitic infestations in FF (Adeolu et al., 2019).

Lymphocytes (LYM) play a major role in adaptive immunity. The FF breed had the highest lymphocyte count (74.56 × 10^3/µL), followed by NA (56.70 × 10^3/µL) and NN (38.50 × 10^3/µL). This aligns with findings by Salako et al. (2023), which suggest that breeds with higher lymphocyte counts are more resistant to viral infections. Monocytes (MONO) help in

the breakdown of pathogens and cellular debris. Only FF recorded monocytes (1.20×10^3/µL), while NN and NA had 0.00. The presence of monocytes in FF suggests a more active phagocytic response (Peters et al., 2023).

Table 4 presents the influence of haemoglobin (Hb) genotypes (AA, BB, AB) on haematological parameters, which are crucial indicators of physiological status, immune response, and overall health in animals. Haematological traits such as packed cell volume (PCV), red blood cell count (RBC), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), and white blood cell count (WBC) are significantly affected by genetic variation in Hb genotypes. Packed Cell Volume (PCV) measures the proportion of red blood cells in the blood, which reflects oxygen-carrying capacity and overall haematological health (Adeolu et al., 2019). The BB genotype exhibited the highest PCV (30.64%), followed by AA (25.46%) and AB (22.97%). The higher PCV in BB indicates better oxygen transport and higher erythropoiesis efficiency, which is consistent with findings by Yakubu et al. (2021), who reported that individuals with higher PCV are more resistant to anaemia and dehydration. The lower PCV in AB suggests a possible disadvantage in oxygen transportation, likely due to genetic interactions between AA and BB alleles (Oladele et al., 2020). Red Blood Cell Count (RBC) values followed a similar trend, with BB (2.25×10^6/µL) having the highest count, followed by AA (2.00×10^6/µL) and AB (1.70×10^6/µL). RBC plays a crucial role in oxygen transport, and higher values in BB suggest better adaptation to hypoxic conditions (Bello et al., 2023). The lower RBC in AB may indicate genetic dilution effects, leading to reduced erythropoiesis efficiency, as suggested by Musa et al. (2022).

Mean Corpuscular Volume (MCV) measures the average size of red blood cells and is used to diagnose microcytic, normocytic, or macrocytic anaemia (Oni et al., 2020). The AA and BB genotypes exhibited higher MCV values (136.84 fL and 134.80 fL, respectively) compared to AB (94.40 fL). Higher MCV values suggest larger erythrocytes, which enhance oxygen transport efficiency in BB and AA genotypes (Peters et al., 2021). The significantly lower MCV in AB may be an indication of microcytosis, possibly linked to reduced haemoglobin synthesis (Habibu et al., 2017).

Table 4. Effect of Hb on haematological parameters

Parameters	Hb			SEM
	AA	BB	AB	
PCV	25.46	30.64	22.97	3.55
RBC	2.00	2.25	1.70	0.24
MCV	136.84	134.80	94.40	9.20
MCH	49.51	51.84	33.63	3.42
MCHC	36.37	37.80	25.27	2.52
WBC	9.28	11.57	8.09	1.58
NUET	2.30	4.02	3.07	0.75
BASO	0.10	0.46	0.27	0.12
EOSI	0.11	0.76	0.53	0.17
LYM	40.94	74.76	62.80	12.15
MONO	0.86	0.00	0.00	0.40
THROM	9.80	24.04	12.33	5.51

PCV=packed cell volume, RBC=red blood cell count, MCV=mean corpuscular volume, MCH= mean corpuscular haemoglobin, WBC= white blood cell count, NUET=Neutrophils, BASO=Basophils EOSI=Eosinophils, LYM=Lymphocytes, MONO=Monocytes, THROM=Thrombocytes, genotypes=(AA, BB, AB), FF=frizzled feathered NN=Normal feathered, SEM=standard error of mean

Mean Corpuscular Haemoglobin (MCH) represents the average haemoglobin content per red blood cell. BB recorded the highest MCH (51.84 pg), followed by AA (49.51 pg) and AB (33.63 pg). This suggests that BB and AA genotypes have better haemoglobin content per erythrocyte, leading to efficient oxygen transport (Adeyemi et al., 2021). The lower MCH in AB indicates a potential haemoglobin deficiency, possibly predisposing the animals to anaemia (Salako et al., 2023). Mean Corpuscular Haemoglobin Concentration (MCHC) indicates the concentration of haemoglobin in red blood cells. BB had the highest MCHC (37.80 g/dL), followed by AA (36.37 g/dL) and AB (25.27 g/dL). The significantly lower MCHC in AB suggests reduced haemoglobin saturation in RBCs, which may impair oxygen delivery to tissues (Yakubu et al., 2023). Higher MCHC in BB and AA implies a greater capacity for oxygen transport, making these genotypes more resilient to environmental stress (Habibu et al., 2017). White Blood Cell Count (WBC) plays a critical role in immune response and disease resistance. BB recorded the highest WBC count (11.57 × 10³/μL), followed by AA (9.28 × 10³/μL) and AB (8.09 × 10³/μL). The higher WBC count in BB suggests better immune competence, aligning with findings by Abegunde and Salako (2022)

that breeds with higher WBC counts have enhanced resistance to infections. The lower WBC count in AB could indicate weaker immunity, making these individuals more susceptible to diseases (Adeolu et al., 2019).

Neutrophils (NUET) are essential for innate immunity and first-line defense against infections. The BB genotype had the highest neutrophil count ($4.02 \times 10^3/\mu$L), followed by AB ($3.07 \times 10^3/\mu$L) and AA ($2.30 \times 10^3/\mu$L). This suggests that BB individuals may have superior immune responses, which aligns with studies by Adebayo et al. (2020), who reported that neutrophils are key indicators of bacterial infection resistance. Basophils (BASO) and Eosinophils (EOSI) are involved in allergic reactions and parasitic infections (Bello et al., 2023). BB recorded the highest values for both basophils ($0.46 \times 10^3/\mu$L) and eosinophils ($0.76 \times 10^3/\mu$L), followed by AB ($0.27 \times 10^3/\mu$L and $0.53 \times 10^3/\mu$L, respectively), while AA had the lowest values ($0.10 \times 10^3/\mu$L and $0.11 \times 10^3/\mu$L). This suggests that BB may have a heightened response to allergens or parasites, which could be advantageous in parasite-prone environments (Adeyemi et al., 2021).

Lymphocytes (LYM) are crucial for adaptive immunity. BB had the highest lymphocyte count ($74.76 \times 10^3/\mu$L), followed by AB ($62.80 \times 10^3/\mu$L) and AA ($40.94 \times 10^3/\mu$L). Higher lymphocyte counts in BB and AB suggest stronger immune memory and resistance to viral infections, aligning with findings by Oladele et al. (2020). Monocytes (MONO) help in phagocytosis and immune regulation (Peters et al., 2021). Interestingly, only AA recorded monocytes ($0.86 \times 10^3/\mu$L), while BB and AB had none. This suggests that AA might have a unique advantage in cellular immunity, as supported by Yakubu et al. (2023). Thrombocytes (THROM) (platelets) are responsible for blood clotting and wound healing (Musa et al., 2022). BB had the highest platelet count ($24.04 \times 10^3/\mu$L), followed by AB ($12.33 \times 10^3/\mu$L) and AA ($9.80 \times 10^3/\mu$L). Higher thrombocyte counts in BB suggest better clotting efficiency, reducing the risk of excessive bleeding, which is advantageous in high-stress environments (Habibu et al., 2017).

Conclusion

This study demonstrates significant variations in linear body measurements and haematological parameters across breeds and haemoglobin (Hb) genotypes. Among the breeds, NA exhibited superior body weight and chest circumference, while NN had the highest shank length. FF recorded the lowest values in most morphometric traits, indicating a potential disadvantage in body conformation. Haematologically, NA had the highest PCV and WBC, suggesting better oxygen transport and immune function. Similarly, BB genotype

showed superior haematological indices, with the highest PCV and WBC, indicating better physiological adaptability. These findings are crucial for genetic selection and breeding programs aimed at improving productivity and disease resistance in livestock.

Conflict of Interest

The authors declare no conflict of interest.

Authors' Contributions

The authors declare that they have contributed equally to the article.

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