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Assessment of Growth Performance and Biometric Traits of Four Indigenous Chicken (*Gallus domesticus*) Genotypes in Ghana

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Abstract

THE study aimed to assess the growth potential and biometric traits of four Ghanaian indigenous chicken genotypes. One hundred and twelve birds of mixed sexes, including Naked-neck, Normal-feathered, Frizzle, and Silky, were kept for twenty-four weeks using a Randomized Complete Block Design (RCBD). There were twenty-eight birds with four replications for each of the four genotypes. Data on growth parameters (feed intake, body weight, body weight gain, and feed conversion efficiency) and linear body measurements such as chest circumference (CC), shank length (SL), body length (BL), comb height (CH), wing length (WL), shank circumference (SC), wingspan (WS), neck length (NL), thigh length (THL), leg length (LL), and beak length (BkL) were collected on a daily, weekly, and monthly basis. Analysis of variance was used to analyze the data, and significant means were isolated. The findings indicated that breed significantly impacted body weight, with the local chicken showing important differences ($P<0.05$), particularly the Naked-neck genotype, which demonstrated superiority. The Frizzle exhibited the highest average daily feed intake value (55.6 g/d), while the Silky had the lowest (44.8 g/d). The feed conversion ratio of the Naked-neck chickens was higher than that of their counterparts. The results also revealed significant differences ($P<0.05$) in linear body parameters among the genotypes. Generally, a positive correlation was observed between body weight and linear body measurements, with the Naked-neck chickens recording the highest values in most linear body parameters. It was concluded that Naked-neck has the potential to provide excellent body weight and growth rate.

Keywords: Correlation, Frizzle, Naked-Neck, Normal-Feathered, Silky.

Introduction

Most areas of Ghana rely heavily on local poultry, particularly domestic chickens (*Gallus domesticus*) and guinea fowl (*Numida meleagris*), for meat and egg production. In Ghana, local chickens are widely distributed across rural communities and are primarily raised as sources of protein and income [1]. According to [1], indigenous chickens possess specific adaptation traits that enable them to thrive more effectively in the local environment than their foreign counterparts. They represent a crucial sub-sector of poultry production in Ghana and Sub-Saharan Africa [2]. Despite their inherent advantages, such as superior meat and egg flavor, high adaptability to changing environmental conditions, hardiness, significant genetic variability in performance, disease resistance, ease of rearing, and reproductive capacity, local chickens receive less attention than those in other developing countries [3]. The lack of stable native breeds suitable for selection and economic breeding for higher output under

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extreme temperatures has resulted in minimal research focus on local poultry farming in Ghana [3].

Despite their importance, they remain largely uncharacterized in terms of growth performance and body morphology, which limits their effective use in breeding programs. Studies in Ghana have shown extensive phenotypic variation within Ghanaian chicken ecotypes. For example, [4] discovered that Coastal, Forest, and Savannah ecotypes exhibited differences in egg yields, feed intake, and feed conversion efficiency. Additionally, [5] identified three ecotypes through Single Nucleotide Polymorphism genotyping and biometric traits, revealing that Interior Savannah birds generally performed better than others. Ghanaian local chickens possess high genetic diversity and vary little across different agro-ecological zones, as reported by [6] using DArT Seq SNP markers. This high genetic diversity enhances the potential for selective breeding. Unfortunately, phenotypic traits such as comb length, shank length, and body proportions are underutilized when considering growth performance in Ghana. The economic value of traits like feed intake, feed conversion ratio, body weight, body weight gain, and linear/morphometric characters suggests these should be considered when designing breeding programs to improve local chickens. Moreover, several conformational traits, beyond body weight, are recognized as reliable indicators of market value and growth in chickens. Efforts have been made to establish relationships between body weight and linear measurements, including trunk length, neck length, drumstick length, shank length, and breast girth [4, 5, 6]. One important factor influencing an animal's market value is live body weight [7]. Linear body measurements offer an indirect way to estimate body weight and have proven to be valuable, quick, simple, and cost-effective methods [8, 9]. However, there has been limited research on this relationship in Ghanaian chicken genotypes at various ages. Therefore, it is necessary to study the genetic behavior of these traits in local Ghanaian chickens so they can serve as standards for production and selection within breeding programs. This study aimed to assess the growth performance and biometric traits of four local Ghanaian chicken genotypes and to examine the relationship between linear body measurements and body weight for effective selection and breeding.

Material and Methods

Study area

The study was carried out in a portion of the Zaaley Commercial Poultry Farm in the Sagnarigu Municipality of Northern Ghana. The study was carried out from September 2024 to March 2025. Saganarigu is one of the sixteen districts in Northern Ghana. The Municipal was a part of the Tamale Metropolis until it was divided on June 24, 2012, to create the Sagnarigu District [10]. It falls between longitudes 0^o 36' and 0^o 57' West and latitudes 9^o16' and 9^o34' North. It has its boundaries with the Tamale Metropolis to the South-East, West to the Tolon District, North to the Savelugu Municipality, and Kumbungu District to the North-West [10]. According to the 2021 Population and Housing Census, the municipality has a land area of approximately 200.41 km^2 and a total population of 341,712, with 170198 males and 171513 females [10]. Farming and its allied activities employ about 50% of the population in the area. Livestock farming is mainly practiced along with crop production in the Municipality. Animals such as guinea fowl, chickens, goats, sheep, and cattle are mainly raised in the municipality. Tropical dry and wet weather prevails throughout the municipality. The rainy season is from April until September or October. The average annual precipitation is 1100 mm, and the relative humidity is usually about 49.9%. Additionally, the Municipality experiences daily temperatures between 27.5°C to 39.8 °C [11].

Management of Animals

Six hundred and thirteen chicks were purchased within 24 hours of hatching from three local commercial farmers in Kpalsi, Gurugu, and Nyohini, all suburbs of the municipal capital (Sagnarigu). After purchase, the chicks were brooded for three weeks at a temperature of 34°C. From these, one hundred and twelve were randomly selected, including forty-seven males and sixty-five females, for the study. Twenty-eight chicks from each of the Naked-neck, Frizzled, Silky, and Normal/Typical feathered chicken genotypes were used. The genetic groups were reared for twenty-four weeks. Medication was administered as needed. For easy identification, all chicks were wing-tagged with unique numbers and kept under the same management procedures throughout the experiment. Although all genotypes experienced uniform management practices regarding feeding, watering, and health care, the placement and orientation of the housing areas differed in ventilation and light exposure due to their positions relative to doors and windows. To control for this spatial variability, a Randomized Complete Block Design (RCBD) was employed. Four blocks accounted for environmental differences across the field. Each genotype was randomly assigned to each block, with each genotype appearing once per block. This arrangement was replicated four times for each genotype, with seven birds per replicate. The housing had cemented floors covered with wood shavings. Each cage was enclosed with wire mesh from top to bottom, leaving the entrance open. Energy-efficient bulbs were installed at focal points within the cages. From the second to the fourth week of age, the birds were fed a diet containing 2995 Kcal/kg of metabolizable energy (ME) and 20.2% crude protein. From five to twenty weeks of age, they received growers' mash with approximately 2716 Kcal/kg ME and 15.85% crude protein (Table 1). Throughout the trial, clean water and feed were available ad libitum. Feed was measured and distributed each morning, and leftovers were weighed the next day to determine intake. The chicks received glucose and antibiotics upon arrival, were dewormed later, and received appropriate medication throughout the study period. Deaths were recorded as they occurred. The chemical composition of the feed supplied at different growth stages is shown in Table 1.

Data collection

The data was taken daily, weekly, or fortnightly, depending on the parameter.

Production Traits

- *Weekly body weight (WBWT):* Individual body weight (g) was recorded from chickens of the four genotypes every two weeks. The body weights were measured using the Camry top-loading sensitive scale with a sensitivity of 0.1g. Body weight gain (g/bird) was calculated by subtracting the initial weight from the final weight.
- *Weekly feed intake (WFI):* Leftover feeds were weighed the next morning to ascertain the amount consumed. The difference between the amount of feed delivered and what was left over represented the birds' feed intake.
- *Feed conversion ratio (FCR*): This measures the amount of feed used per unit increase in weight or quantity produced. In this research, FCR was estimated from the ratio of the body weight gain to the feed intake. As a result, FCR = feed intake/weight gain.

Linear body measurements

Eleven linear body measurements were recorded for the chickens using a textile measuring tape as follows:

- *Chest circumference (CC):* Circumference or girth of the chicken's chest area. It was taken by wrapping a measuring tape around the widest part of the bird's chest.
- *Shank length (SL)**:*** The distance from the ankle joint to the base of the toes on the chicken's leg.
- *Body length (BL)**:*** The distance from the base of the neck (where it meets the body) to the base of the tail.
- *Comb height (CH):* The vertical height of the comb on top of the chicken's head.
- *Wing length (WL)**:*** The distance from the shoulder joint to the tip of the longest primary feather on the wing when extended.
- *Shank circumference (SC):* It is the girth or circumference of the chicken's leg, typically measured at the thickest part of the lower leg.
- *Wing span (WS):* The distance from the tip of one wing to the tip of the opposite wing when extended. It provides an indication of the overall width of the chicken when its wings are fully extended.
- *Neck length (NL):* It is the measurement from the base of the neck to the tip of the beak.
- *Thigh length (THL):* The distance from the hip joint to the knee joint on the chicken's leg.
- *Leg length (LL):* The distance between the coxo-femoral joint and the tibiofemoral joint.
- *Beak length (BkL)**:*** The distance from the tip of the upper mandible to the corner of the two mandibles.

Statistical analysis

The data collected on growth parameters and linear body measurements from four local chicken genotypes were analyzed using the Statistical Package for the Social Sciences (SPSS) version 17.0, with significance differences determined at 5% level. Analysis of variance (ANOVA) was used to compare the treatment means of body weight and linear body measurements, including blocks as a random effect to account for variation due to block differences. This method aimed to ensure accurate comparisons among genotypes and improve the statistical power of the test. Pearson's correlation coefficient (r) was employed to evaluate the relationship between body weight and linear body measurements. For body weight and body weight gain, differences between means were separated using the Least Significant Difference (LSD) Test within the fixed model shown below.

$Y_{ij} = \mu + G_i + B_j + e_{ijk}$................................ (1)
Fixed model

Where:

Y_{ij} = performance/productivity of the i^{th} bird at a particular age

μ= General mean common to all observations

G_i = effects of the i^{th} genotype (i = 1, 2, 3, 4)

B_j = effects of the j^{th} block (j = 1, 2, 3, 4)

e_{ijk} = error term common to all means

According to [12], Pearson's correlation coefficients are estimated using the formula below;

$$\rho(X,Y) = \frac{Cov(X,Y)}{\sigma X \cdot \sigma Y}$$

where;

X and Y = The two separate traits measured on a genotype.

Cov (X and Y) = Covariance of the two traits measured on a genotype.

σX = Standard deviation obtained on trait X.
σY= Standard deviation obtained on trait Y

Results

The results for the body weight (BWT) of the four genotypes of Ghanaian local chickens are shown in Table 2. The two-week body weight of the birds was significantly different (P < 0.05). The body weight of the Silky genotype in the fourth week was higher (P<0.05) compared to the other three strains. However, the four-week weights of the Silky (262.5g) and the Frizzle (251.2g) did not differ significantly (P>0.05). No significant differences (P<0.05) were observed in the body weight of the Frizzle and the Naked-neck. From the sixth to the twenty-fourth week, the trend in performance of the local chickens showed significant variations (P<0.05), with the Naked-neck maintaining superiority.

Table 3 revealed the average daily weight gain for the four local chicken strains. The observed daily weight gains for the four strains differed significantly (P<0.05). The highest daily weight gain was observed between weeks 10-12 by the Naked-neck. The results generally indicated that the Naked-neck recorded the highest average daily weight gain throughout the study period.

Results on the feed intake (FI) and feed conversion ratio (FCR) of the four local chicken genotypes are presented in Table 4. Significant differences (P<0.05) were recorded in the average daily feed consumption and daily feed conversion ratio between the chicken genotypes. The frizzle chicken breeds had the largest average daily feed intake (55.6g/d) while the silky consumed an average of 44.8g/d for the study period. Even though there were significant differences (P<0.05) in feed intake, the Frizzle and Normal-feathered recorded similar (P>0.05) feed intake, and the Naked-neck and the Silky also consumed similar (P>0.05) feed per day. In addition, the feed conversion ratio (FCR) differed significantly (P<0.05) between breeds. Frizzle feathered chickens had the greatest FCR value of 5.19, whereas Naked-neck birds had the lowest with 3.48. This indicates that the Naked-neck tends to convert feed consumed efficiently into body weight than the contemporary.

The genotype of the local chickens' linear characteristics is compiled in Table 5. Every linear feature in this study differed considerably (P<0.05) depending on the genotype of the birds. Apart from comb height (CH), Shank Circumference (SC), Thigh Length (THL), and Beak Length (BkL), the naked neck genotype recorded the highest values in the other linear body parameters. Differences were observed in all eleven linear parameters measured. The silky genotype was seen to outperform in the Comb height, shank circumference, and beak length, while the Frizzle recorded the longest LL.

Phenotypic correlation between body weight and linear body measurements

The correlation between body weight and linear body measurements in the silky genotype is presented in Table 6. Body weight correlated positively with most of the linear traits at 16 and 22 weeks and negatively at 10 weeks of age. Except for the shank length (SL), body weight at 22 weeks had a positive correlation with every linear body parameter.

The relationship between the different biometric/linear characteristics of the native Naked-neck chicken is displayed in Table 7. Generally, there was a positive correlation across all age groups with all the parameters measured. However, week ten saw the highest positive correlation (r = 0.76) between live body weight and SC. However, for week twenty-two, live body weight correlates strongly with BL (r = 0.55), while week sixteen recorded the highest correlation between body weight and both LL and BkL. (r=0.44).

Figure 1 shows the correlation between the various linear body parameters of the local Frizzle chicken. Positive correlations were mostly observed in the ten, sixteen, and twenty-two weeks. The NL had the highest positive correlation in the sixteenth week (r = 0.58), while the highest correlation in the twenty-second week was CC (r = 054).

The results presented in Figure 2 demonstrate that from ten weeks onward, there were positive correlations between the linear traits and the body weight of the normal feathered bird. Shank Circumference (0.51), Chest Circumference (0.47), and Leg length (0.69) showed the strongest positive correlations for weeks ten, sixteen, and twenty-two, respectively, making them key indicators for predicting growth performance in Normal-feathered chickens at different levels of growth.

Discussion

The significantly greater (P<0.05) body weight of Naked-neck birds from the sixth to the twenty-fourth week confirms the superiority of the Naked Neck compared to the other three genotypes. This result aligns with earlier findings of [13], who recorded a greater body weight for crossbred Naked-neck than for Normal-feathered birds at week 6, specifically 449.0g for the F1 Naked-neck (Na/na) and 409.7g for the Normal-feathered (na/na) birds. The body weight at week twenty was also reported by the same authors to be 1565.4g and 1895.8g for the na/na and F1 Na/na birds, respectively, demonstrating clear differences (P<0.05). Similarly, [15] observed superior body weight in the Naked-neck chickens from week three to week eight compared to Normal-feathered and Frizzle genotypes. These findings underscore the importance of considering genotype differences in poultry breeding programs. These findings suggest that a genotype-linked growth advantage can be found in the Naked-neck birds. A possible explanation for this superiority of the Naked-neck birds may be attributed to the presence of the Naked-neck gene (Na), which has been associated with faster growth. Specifically, [16, 17] linked this occurrence to upregulation of insulin-like growth factor II (IGF-II), which promotes myoblast proliferation and protein synthesis, leading to enhanced muscle development. Interestingly, the Silky birds demonstrated superior performance at week four, but were outperformed beyond that point. This may suggest that the Silky has an early growth advantage but does not translate into sustained growth over time, indicating that this genotype expresses faster early growth rates and possibly plateaus at advanced ages, perhaps due to genetic or metabolic limitations at advanced ages [19].

Conversely, the lower body weights observed among Silky, Frizzle, and Normal-feathered genotypes beyond week six could be aligned to genetic factors associated with slower growth rates, as suggested by [19]. Similarly, an inherent metabolic inefficiency or thermoregulatory disadvantages under the specific environmental conditions of the study, especially for Frizzle birds, which are known to be less heat-tolerant despite their altered feather structure, could also be a contributory factor.

Conversely, [14] studied the growth performance of Frizzle, Normal-Feathered, and Naked-Neck local chickens in Nigeria during an 18-week growing period and found no significant variations ($P>0.05$) at any age, even though those with Normal feathers exhibited some general superiority over the other two counterparts. The body weight of the Normal-feathered (1859.0g) and Naked-neck (2060.0g) chicken genotypes at twenty-four weeks of age in the current investigation exceeded the values for the local chicken genotype reported by [18] at a similar age. The better performance of the Naked-neck can also be attributed to their ability to conserve protein for body development, which would otherwise be utilized for feather growth [15]. Naked-neck birds' feather coverage has been estimated to be about 20-40% less; this, in turn, lessens their requirement of nutrient input for feather-building protein. So, Naked-neck birds save protein instead, which likely culminates in rapid growth in these birds [16, 17]. While the current results clearly distinguish genotypic differences in terms of growth performance of the birds under study, some limitations may arise due to the effect of sex within genotypes, which was not isolated; nevertheless, sexual dimorphism also considerably influences body weight in chickens.

Daily body weight gain

A comparison of the growth rate (Daily weight gain) for the four birds indicated that the Naked-neck performed better in daily weight gain than the other three genotypes, except between weeks 18-20. This suggests that the favorable effect of the Naked-neck strain on development under the conditions of this experiment may have persisted throughout the study period, except for weeks 18-20. This contrasts with what [3, 20] reported, that the Frizzle and Naked-neck genes may only affect growth in chickens under normal environmental conditions in the tropics, following the juvenile stages (after six weeks). [13] discovered that over the eighteen-week growth period, there were no differences between the sexes or in the absolute and relative growth rates of the Naked-neck and Frizzle genotypes. According to [16, 17], any benefits that the two main genes under investigation would have due to their direct effects on hens' thermoregulation in hot conditions would most likely appear after advanced ages. Similarly, [21] found that Potchefstroom Koekoek chicken genotypes had significantly higher final body weights and body weight gains than local ones. In line with the findings of [17], the strong genotype effects on body weight, weight increase, feed intake, and feed conversion ratio in the current study indicate the existence of genetic variations among genotypes for these variables.

Feed intake and feed conversion ratio

The significant variations observed in feed intake (FI) across the four indigenous chicken genotypes may suggest a strong influence of genetic background on the feed consumption trait among the four genotypes studied. The highest average daily FI value was observed in Frizzle feathered chickens (55.6g/d) while the least was seen in Silky (44.8g/d). These findings are consistent in trend but vary in magnitude from those reported by [22], who found daily feed intake for a sixteen-week rearing period of Nigerian Local Chicken as 32.4g/d, 31.5g/d, and 31.72g/d for the Normal-feathered, Frizzle, and Naked-neck, respectively. The discrepancy in values between the present and earlier reports could be attributed to differences in genotype origins, environmental conditions, study duration (twenty-four weeks vs. sixteen weeks), dietary composition, and sex distribution. The higher FI recorded could be attributed to their peculiar feather morphology, which may affect the thermoregulation of the birds, resulting in an increased FI [6, 7, 23]. [23] also reported major variations in the FI of two Nigerian Local Chicken (Normal-feathered and Naked-neck) fed with moderate crude protein. In their report, the Naked-neck was found to consume 40.29g/d, and the Normal-feathered consumed 41.42g/d.

The total amount of feed consumed for weight gain is known as the feed conversion ratio (FCR). It is important to note that although the Frizzle genotype recorded the highest FI, it was not translated into superior weight gain. This highlights the importance of evaluating FCR alongside FI to assess feed efficiency. In this study, Frizzle birds also recorded the highest FCR (5.19), indicating lower feed efficiency, while the Naked-neck birds recorded the lowest FCR (3.48), suggesting superior feed utilization. This indicates that the Naked-neck can efficiently convert the feed it consumes into body weight. These results align with [22], who found that Naked-neck chickens had a higher feed conversion ratio of 2.51 compared to Normal-feathered chickens with 2.62 when both were fed a high crude protein diet. Similarly, [21] reported feed conversion ratios for the Normal, Frizzle, and Naked-neck to be 4.40, 4.53, and 3.84, respectively, supporting the pattern observed in this current study. Additionally, [22] discovered that although the Normal-feathered chicks weighed 8.92 percent more than the Naked-neck chicks on day one, the Naked-neck chicks had a higher feed conversion ratio, resulting in approximately 8.6 percent greater weight at 12 weeks ($P<0.05$). This was attributed to the reduced feather mass, which mitigates the adverse effects of hot weather on feed consumption, growth, and meat yield in birds by minimizing excessive body temperature rises caused by eating and digesting in tropical environments. Naked-neck broilers may dissipate more heat and consequently consume more feed since they have more exposed skin. However, environmental parameters such as humidity and temperature were not recorded or analyzed during the current study; these factors are also known to significantly affect both FI and FCR in local chickens.

Linear Body Measurements of the Local Chicken Genotypes

In the current study, the Naked-neck genotype recorded higher values in several linear body parameters, including neck length, chest circumference, body length, and wing length. This aligns with findings reported by [13], who discovered that Naked-neck chickens exhibited superior linear body measurements compared to the Normal-feathered and Frizzle genotypes in a tropical environment. Nonetheless, the wing span values recorded in the current study were significantly higher than those reported by [25] in the North Gonder zone of Nigeria. These observed variations may also be attributed to differences in feed availability, environmental conditions, or genotype.

According to [13], the enhanced linear measurements in Naked-neck chickens may be attributed to the Na gene, which reduces feather coverage, thereby improving heat dissipation and growth efficiency. This genetic adaptation could explain the consistently higher measurements observed in this genotype in the current study. However, not all parameters favored the Naked-neck birds in the current study. The Silky genotype exhibited higher values for shank circumference, beak length, and comb height. These features may indicate potential breed-specific morphological traits or specific adaptive traits variations. Interestingly, the Frizzle genotype recorded the longest leg length (LL), which diverges from the pattern of other body traits. This could suggest that certain genotypes have trait-specific advantages, potentially due to skeletal or muscular development patterns unique to their genetic make-up. However, the greater comb length or height values from the current study are comparable to those reported by [24] for the Horro and Jarso chicken populations. The larger comb dimensions of the silky chicken relative to other native varieties may suggest a greater adaptation to hot agro-climatic conditions. Additionally, the sizes of the comb differed from those found by [25]. Contrary to [13], who discovered that the normal-feathered outperformed both Frizzle and Naked-neck chickens in body linear measurements over an 18-week production period, the current study observed lower performance in Normal-feathered birds. Such discrepancies may be associated with differences in genetic diversity within the breed, environmental stressors, management practices, or sample size variability [26].

Correlation between body weight and linear body measurements

Generally, the results of this study indicate a positive relationship between several linear body measurements and body weight at different ages. Linear body measurements showed strong positive correlations with body weight during specific weeks. The positive and significant correlation between body weight and other body measurements suggests that these easily measured parts can be used to estimate body weight and, therefore, serve as selection criteria to improve body weight in the local chicken genotypes in Ghana. These findings align with earlier studies by [27], who found that among Ethiopian native chickens, body weight positively correlated with several linear body parameters, including BL ($r = 0.67$), SC ($r = 0.69$), and CC ($r = 0.52$) in males, and SC ($r = 0.59$) and BL ($r = 0.68$) in females. It was also strongly correlated with SL ($r = 0.76$) in both sexes [26]. This work also agrees with previous research by [28], who stated that a correlation exists between linear body measurements of Cobb grill chickens and body weight. The study's results imply that, in the chicken genotypes studied, body weight can potentially be increased by selecting traits such as SC, WS, CC, NL, LL, BL, and CC within a breeding program aimed at improving the weight of local chickens. This variation may be due to differences in breed. Additionally, a study by [29] on three chicken genotypes (Boschveld, Astrolope, and indigenous Sacco) showed that the correlation between linear measurements and body weight varies with age and genotype, similar to the current study. The findings suggest that body weight prediction models should be specific to each genotype.

Conversely, [30] reported that, in the Potchefstroom Koekoek breed, BW had a highly positive statistically significant correlation (P<0.01) with WL (r = 0.76), whereas in the Hy-line Silver Brown layer breed, BW had a negative statistically significant correlation (P<0.05) with WL (r = -0.27). These findings contrast with earlier research by [31], who found that traits such as wattle length, comb length, wingspan, shank length, comb height, and keel length could explain 62.43% of the body weight in indigenous chickens. The different genotypes involved may explain this variation. According to this study, choosing one of these linear body measurements for selection depends on the bird's type and age at weight measurement. Although the correlations observed were generally positive, they differed across age and genotype groups. This variation is expected because growth patterns and the expression of morphometric traits are influenced by nutrition, environment, and genetics [28]. It is important to note that while high correlation values suggest predictive potential, they do not always imply causation. The strong correlations between BW and other traits in this study could reflect shared growth or genetic factors rather than direct cause-and-effect relationships. To analyze this further, path coefficient analysis was used in Nigerian indigenous chickens to decompose total correlation into direct and indirect effects [32]. The differences in trait–weight correlations based on genotype and age reflect physiological changes: early growth optimizes bone development (such as traits of shank and keel), while later growth emphasizes muscle and fat deposition, enhancing trait expression [32].

Conclusion

The Naked-neck genotype exhibited superior growth performance from the sixth to the twenty-fourth week of age, achieving the best feed conversion efficiency. The Silky genotype excelled in the early growth stages. Variations in certain phenotypic performances may suggest that these local chickens possess a degree of genetic diversity. The Naked-neck birds attained the highest values in most of the linear traits measured. Utilizing specific linear body measurements can directly enhance body weight in chickens. Shank circumference at ten weeks, chest circumference at sixteen weeks, and leg length at twenty-two weeks demonstrated the strongest positive correlations with body weight in Normal-feathered chickens. The findings from this study indicate that selecting specific linear body measurements in local chickens can directly help achieve optimal body weight at various growth stages. For the Silky, Naked-neck, and Normal-feathered genotypes, shank circumference (SC) is the best predictor of body weight at week ten. However, wing span (WS), chest circumference (CC), and neck length (NL) are most effective for week sixteen, while leg length (LL), body length (BL), and CC can predict optimal body weight for the genotypes at week twenty-two. Breeders should prioritize these key linear traits when forecasting body weight during these growth stages in a breeding program aimed at improving local chickens in Ghana. Future research could utilize Multivariate Adaptive Regression Splines (MARS) and Classification and Regression Trees (CART) to assess the impact of linear body measurements on body weight in Ghanaian Local Chicken.

Conflict of interest statement

We disclosed that we do not hold any conflicts of interest in the publication of this article.

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Author`s contribution

Yaw Amevor was responsible for designing the study plan and conducting the research. Duodu Addison supervised the research process and proofread the script. Abubakari Abdul-Nasir co-supervised the research and interpreted the analyzed data. Joseph K. Sosu drafted the manuscript. The data was analyzed by Mohammed Masahudu. Sako M. Husain assisted with writing the manuscript, while Christian Duah provided technical help and also proofread the manuscript.

TABLE 1. Composition of the Diet Supplied to Birds

Ingredient	Starter mash (kg)	Grower mash (kg)
Maize	46.50	55.45
Groundnut cake	24.63	15
Soy bean meal	18.00	20
Fish meal	2.50	2.0
Bone meal	2.50	1.5
Limestone	5.00	5.00
Vitamin & Mineral Premix	0.250	0.25
Salt	0.30	0.30
Lysine	0.250	0.25
Methionine	0.250	0.25
Total	100	100
***Calculated* CP**	20.17%	15.85%
ME, Kcal/Kg	2,995	2,715

TABLE 2. Effects of genotype on the weekly body weight of local chicken

Weekly Body Weight (g)	Genotype				
	Silky	Naked-neck	Frizzle	Normal	SE
Initial	125.9	140.4	122.9	98.8	4.61
4	262.5[a]	238.3[b]	251.2[ab]	213.3[c]	11.70
6	376.2[b]	394.0[a]	419.0[a]	376.3[b]	14.97
8	541.9[bc]	568.8[ab]	582.7[a]	524.9[c]	18.35
10	747.4[b]	807.0[a]	730.5[b]	701.1[b]	19.21
12	919.8[b]	1055.7[a]	916.5[b]	883.4[b]	25.68
14	1103.0[b]	1215.0[a]	1059b[c]	1035[c]	29.40
16	1337.0[a]	1400.0[a]	1200.0[b]	1174[b]	33.10
18	1477.0[b]	1624.0[a]	1348.0[b]	1340.0[b]	35.10
20	1627.0[b]	1736.0[a]	1480.0[c]	1536.0[c]	33.30
22	1763.0[b]	1909.0[a]	1642.0[c]	1686.0[c]	36.60
24	1934.0[b]	2060.0[a]	1829.0[c]	1859.0[c]	35.30

[abc]Means in the same row with different superscripts are significantly different at P<0.05. SE = Standard Error

TABLE 3. Effects of Genotype on Daily Weight Gain of Local Chicken

Daily Weight Gain (g)	Genotype				
	Silky	Naked-neck	Frizzle	Normal	SE
Initial-4	9.76[a]	7.00[c]	9.17[a]	8.18[b]	0.67
4-6	8.12[b]	11.10[a]	11.99[a]	11.65[a]	0.83
6-8	11.84[a]	12.49[a]	11.69[a]	10.62[b]	0.87
8-10	14.68[b]	17.03[a]	10.56[d]	12.58[c]	1.01
10-12	12.32[b]	17.77[a]	13.29[b]	13.02[b]	1.02
12-14	13.09[a]	11.38[a]	10.18b[c]	10.83[c]	1.05
14-16	16.72[a]	13.22[b]	10.07[c]	9.93[c]	1.86
16-18	10.00[c]	16.00[a]	10.57[c]	11.86[b]	0.70
18-20	10.72[b]	8.0[d]	9.43[d]	14.00[c]	1.01
20-22	9.72[c]	12.36[a]	11.57[b]	10.72[a]	1.14
22-24	12.22[b]	10.79[c]	13.36[b]	12.36[a]	1.0

[abc]Means in the same row with different superscripts are significantly different at P<0.05, SE= Standard Error

TABLE 4. Feed intake and feed conversion ratio of local chicken genotypes.

Parameter	Genotype				
	Silky	Naked-neck	Frizzle	Normal	SE
FI (24 weeks g/day)	44.8[b]	45.9[b]	55.6[a]	53.5[a]	1.62
FCR	3.81[c]	3.48[c]	5.19[a]	4.76[b]	0.18

[abc]Means in the same row with different superscripts are significantly different at P<0.05.
FCR = Feed Convection Ratio; FI = Feed Intake; SE = Standard Error

TABLE 5. Linear body measurements of local chicken genotypes.

Parameters	Genotype				
	Silky	Naked-neck	Frizzle	Normal	SEM
FBW	1934.0	2060.0	1829.0	1859.0	35.30
CC	18.80[c]	24.54[a]	17.87[c]	22.40[b]	0.70
SL	7.41[b]	8.01[a]	6.60[c]	6.34[c]	0.93
BL	31.51[c]	39.31[a]	35.15[b]	35.27[b]	1.70
CH	1.91[a]	1.16[b]	1.18[b]	1.10[b]	1.10
WL	18.12[c]	20.67[a]	16.82[b]	16.43[b]	1.02
SC	10.19[a]	10.17[a]	9.16[b]	9.41[b]	1.03
WS	37.31[b]	40.31[a]	34.59b[c]	36.08[c]	1.06
NL	11.80[b]	17.61[a]	12.47[b]	11.41[b]	0.90
THL	6.79[c]	9.11[a]	8.58[b]	8.29[b]	0.56
LL	18.10[b]	18.20[b]	21.13[a]	17.49[c]	0.82
BkL	3.60[a]	3.00[b]	2.45[c]	3.08[b]	0.64

[abc]Means in the same row with different superscripts are significantly different at P<0.05, Final Body weight (FBW), Chest Circumference (CC), Shank Length (SL), Body length (BL), Comb Height (CH), Wing length (WL), Shank Circumference (SC), Wingspan (WS), Neck length (NL), Thigh length (THL), Leg length (LL) and Beak length (BkL); SE= Standard Error

TABLE 6. Correlation between body weight and linear body measurements for the silky chicken.

Parameters	Weeks		
	10	**16**	**22**
BW	747.4	1337.0	1763.0
CC	-0.12	0.41	0.06
SL	0.41	0.48	-0.25
BL	-0.26	0.19	0.46
CH	0.39	0.25	0.16
WL	-0.12	0.43	0.15
SC	0.54	0.41	0.06
WS	0.27	0.51	0.32
NL	-0.41	0.06	0.39
THL	-0.04	0.08	0.12
LL	-0.23	0.44	0.48
BkL	-0.21	-0.13	0.04

Final Body weight (FBW), Chest Circumference (CC), Shank Length (SL), Body length (BL), Comb Height (CH), Wing length (WL), Shank Circumference (SC), Wingspan (WS), Neck length (NL), Thigh length (THL), Leg length (LL) and Beak length (BkL).

TABLE 7. Correlation coefficient between body weight and linear body measurements for the naked-neck chicken

Parameters	Weeks		
	10	**16**	**22**
BW	807.0	1400.0	1909.0
CC	0.05	0.47	0.18
SL	0.39	0.09	0.06
BL	0.33	0.26	0.55
CH	0.24	0.04	0.45
WL	0.34	0.34	0.05
SC	0.76	0.29	0.31
WS	0.50	0.24	0.27
NL	0.26	0.14	0.10
THL	0.54	0.08	0.46
LL	0.42	0.44	0.13
BkL	0.51	0.44	0.08

Body weight (BW), Chest Circumference (CC), Shank Length (SL), Body length (BL), Comb Height (CH), Wing length (WL), Shank Circumference (SC), Wingspan (WS), Neck length (NL), Thigh length (THL), Leg length (LL) and Beak length (BkL).

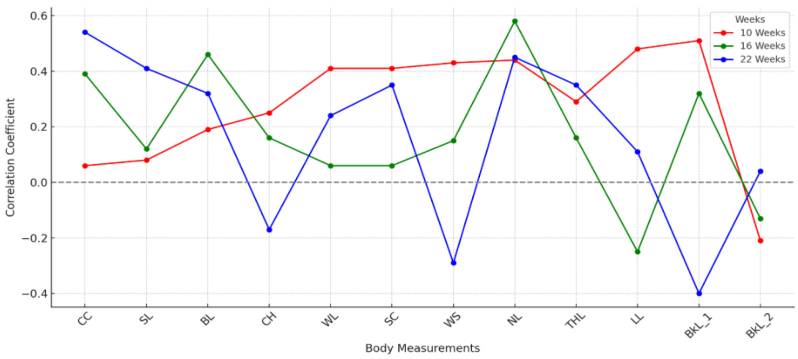

Fig. 1. Correlation between body weight and linear body measurements of the frizzle chicken.

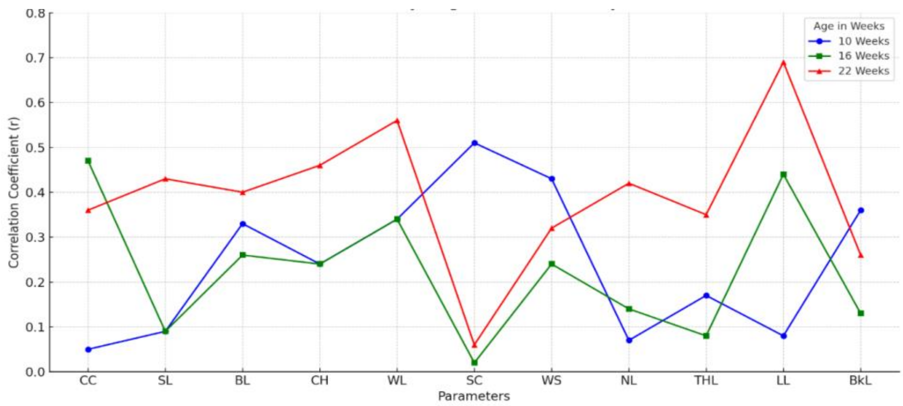

Fig. 2. Correlation between normal-feathered body weight and linear body measurements.

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