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Comparative Evaluation of Seasonal Variation on Growth Performance and Morphometric Traits in Broiler Chicken Strains Raised in the Tropics

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ABSTRACT

The most suitable strains of broilers that are compatible with the effects of climate change in the geographical region were identified by comparing the evaluation of seasonal variation on growth performance and morphometric characteristics of various strains of broilers. For the span of a seven-week trial, a total of 300-day-old chicks comprising 72 Ross 308, 72 Arbor acre, 72 Marshal, and 72 Cobb 500 were used (Wet and Dry season). Data was collected on morphometric characteristics and growth performance and were subjected to a student's t-test at a 5% level of significance, the findings of the study, all strains revealed no noticeable variations in growth performance nor morphometric traits during the rainy season, however, all strains showed significant effects on all parameters examined during the dry season for growth performance and morphometric characteristics. Except for the Cobb 500 strain, which displayed a positive correlation, all other strains exhibited a negative correlation with feed intake. With its highest final live weight of 3310.80g, feed conversion ratio of 1.32, body girth of 40.22cm, and thigh length of 19.55cm among other strains, Cobb 500 performed exceedingly well to temperature fluctuations. Therefore, according to the study, it can be stated that the Cobb 500 can be raised in the tropics with high-temperature shifts during the dry season (January–April).

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INTRODUCTION

In developing nations like Nigeria, there has been a growing push for increased consumption of animal-derived protein. To meet this growing need, there is an emphasis on breeding animals with rapid reproductive cycles and high productivity (Nosike et al., 2018; Sanubi et al., 2023a). Therefore, the poultry industry, particularly

broiler chicken rearing for eggs, meat and agricultural purposes, stands out for its rapid growth, low capital investment, short lifecycle, and high profits (Cui et al., 2020; Ade et al., 2023). Furthermore, this sector is known for its rapid growth, cost-effectiveness, and high profitability, broiler chicken production is expected to play a pivotal role in meeting the protein requirements of an expanding population (Ramukhithi et al., 2023).

It has been ascribed those certain measurements like breast, thigh, and shank length, serving as essential indicators, showing a positive correlation with live body weight according to Nosike et al. (2017). Leveraging these measurements in selective breeding programs especially emphasizing larger breast sizes, has led to substantial improvements, as evidenced by studies conducted by Ukwu et al. (2014) and Udeh et al. (2015). The significance of body weight as an economic determinant in the meat industry further underscores its influence on breeding choices for future generations (Sanubi et al., 2023b).

However, the growth of broilers is influenced by genetic and environmental factors (Udeh and Ighebesuo, 2023). The choice of season for raising broilers plays a crucial role in optimizing output. Environmental variables like seasonal variations, climate changes, and extreme weather significantly impact broiler productivity and profitability (Kumar et al., 2021). Notably, environmental temperature, a prominent abiotic factor, profoundly affects metabolism and overall broiler performance (Abioja and Abiona, 2021). Temperature deviations from the comfort zone, whether high or low, can harm broilers, leading to non-uniformity in flocks. Various factors, including age, sex, breed, weight, activity level, molting, broodiness, feeding, and the external environment directly affect broiler tolerance to temperature variations beyond their comfort range (Farag and Alagawany, 2018; Kumar et al., 2021). Lower temperatures have shown positive effects on important growth parameters like feed intake, efficiency, survivability, and weight gain compared to higher temperatures.

Given the significant challenge posed by heat stress, especially in tropical regions, identifying broiler breeds capable of withstanding climate change and heat stress becomes imperative. This study evaluates the effects of seasonal variations (dry and wet seasons) on body weight and morphometric traits in four commercial broiler breeds (Cobb 500, Marshal, Ross 308, Arbor Acre) raised under similar conditions in the tropics.

MATERIAL and METHOD

Ethical Approval:

This study was carried out in accordance with the ethical provisions of the Committee established by the Dennis Osadebay University, Asaba, Nigeria, Ethical Committee on the use of farms animals for research(No: FAG/ETH/202322199).

The Research was conducted at the poultry unit of the Department of Animal Science and Production, Dennis Osadebay University, Anwai, Asaba. Situated between latitude 60º 12¹ North and longitude 60º 45¹ East, Dennis Osadebay University in Asaba, experiences an average annual rainfall ranging between 1800 and 3000 mm with a daytime temperature ranging from 36.15 to 42.92 °C (Asaba Metrological sub-station, 2023).

Experimental Animals and Their Management

For the study, a total of 300 broiler chicks—75 of each of Cobb 500, Marshal, Ross 308, and Arbor Acre plus—were procured from reputable hatcheries. Three chicks were provided to handle mortality while 72 broilers per strain were used for the actual data collection. A complete randomized design (CRD) was used to allocate the Cobb 500, Marshal, Ross 308, and Arbor Acre strains into four treatment groups based on the strain. Each of the treatment groups contained three replicates, The poultry house was divided into 12 pens of four treatments, each with twenty four (24) birds per replicate for each treatment. T1 included Ross 308 strain, T2 Arbor acre strain, T3 Marshal strain, and T4 Cobb 500 strain. The birds were kept under an intensive management system in an open sided poultry house for the duration of the experiment (8 weeks) and were fed the same diet throughout the experiment.

The birds were provided *ad libitum* with a New Hope Professional Broiler starter diet (24 % crude protein and 300 kcal/kg metabolizable energy) and later transitioned to a New Hope Professional Broiler Finisher diet (21 % crude protein and 2800 kcal/kg metabolizable energy) from 4 to 8 weeks of age. The birds were also consistently provided with clean drinking water. The experiment was in two phases for each rearing season: the rainy season (April–October) and the dry season (January–April) and for each season the experiment was repeated three times for both seasons to probe deeper with accuracy (Oguntunji et al., 2008). The broiler chicks received the necessary vaccinations and medications at the appropriate stages of their growth.

Data Collection

Ten birds were picked at random; Body weight (BW), body length (BL), breast girth (BG), wing length (WL), shank length (SL), thigh length (TL), and height (H) were taken weekly for eight consecutive weeks. Following the method described by Udeh et al. (2015), the flexible tape was used to measure the linear body measurements in centimeters.

Live Body Weight

Every week, the experimental birds were captured in an empty box to determine their body weight. By taring the weighing scale (a Camry scale) to zero while the empty box was still on it, the weight of the box was minimized. Weights were recorded and the birds were released from the box.

Breast girth: taken with a measuring tape in centimeters, this is the circumference of the breast around the deepest part of the breast**.**

Shank length: the distance that runs from the tars-metatarsus from the metatarsal pads to the hock joint was measured.

Thigh length: was obtained by measuring the distance between the hips and hock joint.

Wing length: was measured starting from the humorous joint (coracoids) to the tip of the phalanges.

Body Length: Measured from the base of the neck to the tip of the tail.

Height: While the bird was standing, the measurement was measured from its back down to its feet.

Weather Data

The experiment employed weekly average temperature data gathered at the Asaba Meteorological Station at the Dennis Osadebay University sub-station, over an eight-week period.

Statistical Analysis

All collected data was subjected to a student's t-test at a 5% level of significance and was used to compare all parameters measured in the rainy and dry seasons, and the model for a completely randomized design, as described by (Eller et al., 2013), was used for variance analysis. LSD was employed to differentiate between significant shifts in treatment means.

RESULTS and DISCUSSION

Table 1 shows the mean weekly temperature values. The lowest temperature was recorded at week 3 with a range of 29.36-38.75^{o}C and the highest at week 7 with a range of 35.23-42.01^{o}C.

Table 1. Mean weekly temperature range (°C)

Weeks	Minimum	Maximum
1	31.02	39.41
2	34.21	41.30
3	29.36	38.75
4	34.00	41.20
5	31.28	40.24
6	33.14	41.14
7	35.23	42.01
8	32.41	40.13

Source: Asaba Meteorological Station, Dennis Osadebay University, Asaba

Seasonal Variation's Influence on The Four Strains of Broiler Chickens' Growth Performance

Table 2 reveals the growth performance results for the two seasons (rainy and dry). As predicted, the final body weight, weight gain, feed intake, and feed conversion ratios among the strains studied for the rainy season were not significantly ($p>0.05$) different from the other strains. However, the results were significantly ($p<0.05$) different for the dry season. Cobb 500 had the highest final body weight (3310.86 g) and was statistically different from the marshal, whose value was (3000.15 g). For the dry season, Ross 308 and Arbor Acre recorded the lowest values (2284.25 g and 2294.23 g) respectively.

Seasonal Variation's Influence on The Four Strains of Broiler Chickens' Morphometrics Traits

Table 2 summarizes the results of morphometric characteristics in broiler chickens influenced by climatic changes (rainy and dry seasons). The results showed that the body girth, wing length, thigh length, shank length, body length, and body height were not significantly ($p>0.05$) affected among the strains evaluated throughout the rainy season; however, the parameters measured during the dry season such as the body girth, wing length, thigh length, shank length, body length, and body height were significantly ($p<0.05$) different, with cobb 500 having the highest body girth (40.22 cm). The lengthiest wing length, thigh length, shank length, and body length were each considerably different ($p<0.05$). Cobb 500 had the highest wing length, thigh length, and body length, at values of (22.86 cm, 19.55 cm, and 35.71 cm) for each morphometric trait, while Ross 308 had the least wing length, thigh length, and body length (20.03 cm, 16.24 cm, and 30.24 cm) for each morphometric trait. Arbor Acre had the longest shank length (11.91 cm), while Cobb 500 had the shortest shank length (7.44 cm). However, there was no significant difference in body height ($p>0.05$) between the strains.

Table 2. Seasonal influence on the growth performance of four broiler chicken strains

Parameters (g/bird)	Rainy season				Dry season			
	Ross 308	Arbor Acre	Marshal	Cobb 500	Ross 308	Arbor Acre	Marshal	Cobb 500
Initial weight	40.01 ± 0.00	40.01 ± 0.01	40.01 ± 0.01	40.01 ± 0.01	40.01 ± 0.01	40.01± 0.01	40.01 ± 0.01	40.01 ± 0.01
Final body weight	3519.25 ± 186.30	3519.38 ± 186.31	3519.26 ± 186.31	3519.71 ± 186.30	2284.25 ± 136.30^{c}	2294.23 ± 136.35^{c}	3000.15 ± 146.32^{b}	3310.86 ± 167.20^{a}
Weight gain	3479.24 ± 92.45	3479.37 ± 92.45	3479.25 ± 146.34	3479.70 ± 147.20	2244.24 ± 73.95^{c}	2254.22 ± 73.20^{c}	2960.14 ± 140.90^{b}	3269.99 ± 143.34^{a}
Feed intake	4230.46 ± 79.56	4340.04 ± 79.12	4320.81 ± 79.93	4420.47 ± 79.18	2640.80 ± 78.29^{c}	2610.91 ± 78.11^{c}	3650.47 ± 78.09^{b}	4310.44 ± 78.88^{a}
Feed conversion ratio	1.22 ± 0.07	1.25 ± 0.07	1.24 ± 0.04	1.27 ± 0.03	1.18 ± 0.10^{c}	1.16 ± 0.10^{c}	1.23 ± 0.03^{b}	1.32 ± 0.01^{a}

a,b,c, means on the same row with different superscripts are significantly different ($p<0.05$)

Table 3. Seasonal influence on the morphometrics traits of four broiler chicken strains

Traits (cm)	Rainy season				Dry season			
	Ross 308	Arbor Acre	Marshal	Cobb 500	Ross 308	Arbor Acre	Marshal	Cobb 500
Body girth	40.70 ± 0.40	40.87 ± 0.45	40.40 ± 0.56	40.86 ± 0.62	35.19 ± 0.23^{b}	35.40 ± 0.51^{b}	35.40 ± 0.40^{b}	40.22 ± 0.41^{a}
WL	24.03 ± 1.93	24.13 ± 1.91	24.39 ± 1.91	24.71 ± 1.80	20.03 ± 0.30^{b}	20.70 ± 0.35^{b}	21.15 ± 0.32^{b}	22.86 ± 1.20^{a}
THL	18.64 ± 0.62	18.64 ± 0.61	18.74 ± 0.50	19.00 ± 0.68	16.24 ± 0.35^{c}	16.24 ± 0.38^{c}	19.41 ± 0.38a	19.55 ± 0.36^{a}
SHL	8.03 ± 1.79	8.04 ± 1.12	8.81 ± 1.93	8.86 ± 1.18	8.80 ± 1.78^{b}	11.91 ± 2.11^{a}	8.47 ± 2.09^{b}	7.44 ± 1.88^{c}
BDL	34.76 ± 0.48	34.76 ± 0.46	34.14 ± 0.51	34.00 ± 0.40	30.24 ± 0.48^{c}	30.44 ± 0.44^{c}	33.38 ± 0.38^{b}	35.71 ± o.35^{a}
BDH	38.24 ± 0.47	38.24 ± 0.50	38.01 ± 0.68	38.27 ± 0.80	38.34 ± 0.47	38.54 ± 0.50	38.01 ± 0.68	38.27 ± 0.51

a,b,c, means on the same row with different superscripts are significantly ($p<0.05$) different. WL= Wing length, THL= Thigh length, SHL=Shank length, BDH= Body height, BDL= Body length

The influence of seasonal variations on growth performance and morphometric traits of four strains of birds reared in the wet season was not significantly ($p>0.05$) affected across strain groups during this study, which could be attributed to the low ambient temperature recorded (25^{o}C) during the wet season, possibly high desire of the birds to feed consumption, as well as maximum nutrient utilization (Ayo et al., 2022; Onagbesan et al., 2023).

Influence of Seasonal Variations (Dry Season) on Growth Performance

The significant ($p<0.05$) effect on the final body weight of the broiler strains study indicates that there is a genetic difference between the broiler strains, which is in line with (Gwaza et al., 2017; Mebratie et al., 2017). Cobb 500 proved superior capabilities for surviving the dry season rise in temperatures (25^{0}C-38^{o}C), subsequently followed by marshal strain, arbor acre, and Ross 308.

The weight gain results revealed that the Cobb 500 strain had the highest ($p<0.05$) weight gain compared to other strains, and these could be attributed to the Cobb 500's ability to resist harsh temperature changes, and this is in agreement with the finding of (Huwaida et al., 2011; Okusanya and Akinlade, 2019) that the Cobb 500 strain was not affected by seasonal variations, unlike other strains in their separate findings.

Table 1 shows a significant ($p<0.05$) variation in feed intake for the Ross 308 strain, which could be related to ambient temperature effects. This is consistent with the findings of (Mashaly et al., 2004; Tiruneh and Tegene, 2018; Okusanya and Akinlade, 2019; Abioja and Abiona, 2021), who observed that climate change has influenced poultry output by imposing stress on the birds' homeostasis.

The results on feed conversion ratio were significantly ($p<0.05$) higher in Cobb 500, and were not negatively influenced by metabolic heat production, which is associated with broilers and specifically high given their high feed conversion rate compared to other strains of poultry (Abioja and Abiona, 2021).

Influence of Seasonal Variations (Dry season) on Morphometric Traits

Table 2 shows the morphometric traits of the four broiler strains investigated during the dry season. The Cobb 500 had the highest significant values for body girth, body length, wing length, and thigh length, while the Arbor acre had the highest values for shank length measurement, and no significant level was recorded for all strains in body height measurements estimated. This finding of significant variations in body girth is consistent with the trend in the influence of seasonal variation (dry) on weight, indicating a link between body weight and body girth (Ajayi et al., 2016; Akporhuarho 2017). Body girth meat is a vital characteristic in broiler production, and Cobb 500 had the highest body girth meat.

Cobb 500 and Marshal have significantly ($p <0.05$) higher thigh lengths, with records consistent with Ajayi et al. (2016). This is significant because meat from the thigh muscle is another essential economic characteristic for profitability in broiler production. Arbor acre and Ross 308 had the lowest thigh lengths, indicating that the dry season reduces thigh length in these broiler strains.

CONCLUSION and RECOMMENDATIONS

Conclusion

Throughout the rainy season, minimal changes were observed across the broiler strains in terms of growth performance and morphometric traits. The relatively lower ambient temperature during this period (around 25^{o}C) might have facilitated the birds' increased feed intake and optimal nutrient utilization thus reducing the significant influence among the strains. However, during the dry season, where temperatures fluctuated between 25^{o}C and 38^{o}C, distinct genetic differences between the broiler

strains became evident. The Cobb 500 strain exhibited superior adaptability to the increased temperature, displaying higher final body weight and weight compared to other strains. Moreover, the observed variations in feed intake and feed conversion ratio, particularly in the Ross 308 strain, align with the impact of climatic changes on poultry output, influencing the birds' metabolic processes and overall homeostasis.

Morphometric traits revealed intriguing insights. Cobb 500 consistently revealed superior measurements in body girth, body length, wing length, and thigh length during dry season. These features are economically significant in broiler production, highlighting the strain's potential for profitability, particularly under harsh environmental conditions.

Recommendations

Cobb 500 broiler strain can potentially be raised conveniently during the dry season (January-April) in the tropic environment without any hazards to productivity. During the dry season, measures to manage the environmental temperature should be provided, such as tree planting, feed restriction on hot days, and supply of clean and cold water to the birds. Additionally, further research in this area could deepen our understanding of genetic mechanisms underlying strain-specific responses to environmental changes, fostering more resilient poultry farming practices.

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Conflict of Interest

The authors have declared that there are no competing interests.

Authors Contribution

All authors contributed equally to the success of this article.

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