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Research Article

Phenotypic Correlations among Growth Performance Traits and Responses to Feed Restriction in Blood Traits of Two Broiler Strains of Chicken Under Heat Stress

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ABSTRACT
This experiment was conducted to evaluate the early effects of feed restriction and breeds on growth performance and body conformation traits of broiler chicken exposed to heat stress conditions. Ninety-six (96) broiler chicken comprising of two strains were used for this experiment. The two broiler strains were both exposed to either feed restriction at early stage of life or ad libitum (control) under heat stress condition. Data on body weight, body conformation traits and blood traits were obtained and analysed. No significant ($P > 0.05$) effect of breed was observed on body weight and body conformation traits. Body weight and body girth were significantly ($P < 0.05$) higher in the control chickens than in the feed restricted. Significant ($P < 0.05$) interaction effect of feeding and breed was observed on body weight but not on body conformation traits. Positively high and significant correlation ranging from $r = 0.550$, $P < 0.01$ to $r = 0.893$, $P < 0.001$ were recorded between the body weight and body conformation traits from both Arbor Acre and Cobb broiler strains. No significant ($P < 0.05$) effect of breed, feeding and interaction were observed on the blood haematological and biochemical traits. However, alkaline phosphatase was significantly ($P < 0.05$) affected by feeding. It is therefore concluded that, both strains could favourably adapt to heat stress irrespective of feeding regimen. The correlations results revealed strong genetic linkage and association between body weight conformation traits and they could be used as markers for selecting one another.

Keywords: Blood parameters; Broiler strains; Correlation; Feed restriction; Growth performance

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INTRODUCTION

In many developing countries of the world including Nigeria, the broiler industry plays a major role in supplying the population with meat which is highly nutritious and popularly consumed (Ukwu *et al*., 2014). The broiler chicken in Nigeria had served as the major source of protein for the population. Despite their economic importance, poultry production is affected by environmental factors among which include temperature, humidity and nutrition (Orunmuyi, 2006). It has been reported that different broiler strains react differently and have varying capacities to tolerate heat stress. Although certain broiler strains perform better than others and/or are more resilient to climatic variations, broiler chickens generally have low heat stress tolerance since breeding programs are always looking for superior growth performance (Hascik *et al*., 2010; Berrong and Washburn, 1998). In order to counteract the high levels of ROS produced, it is crucial to put mitigation methods into place that can support these broiler strains' physiological antioxidant system. Environmental techniques, such as adopting early feed limitation,

lowering stocking density, boosting ventilation, and creating an intermittent light schedule (Sahin *et al*., 2009). Evaluation of performance of broiler strains is carried out using various indices, such as growth traits (body weight and body linear -measurement). Ebangi and Ibe (1994) reported that body linear measurement has heritable basis and have been identified to play a major role in the subsequent carcass yield of broiler strains. A range of techniques are available to gain information about broiler mass and body conformation. Some of these techniques use simple and inexpensive equipment, while others required sophisticated and expensive equipment (Kabir *et al*., 2010.

Meanwhile, both environmental and genetic factors affect broiler growth (Udeh and Ighebesuo, 2023). Choosing the right season to raise broilers is essential to maximizing production. The production and profitability of broilers are greatly impacted by environmental factors such as seasonal variations, climate change, and harsh weather with sex and breed inclusive (Farag and Alagawany, 2018). Interestingly, one important abiotic element that has a significant impact on metabolism and overall broiler performance is environmental temperature (Abioja and Abiona, 2021). Broiler chickens are faced with various types of stress such as high ambient temperature, transit, feed deprivation, feed contamination stocking density, fear, rearing with unfamiliar individual and diseases (Zulkifli *et al*., 2009). The growth performances of chickens are usually affected by these stresses. Performances of the tropical meat type chickens are usually impaired by heat stress (HS). Lowered feed consumption and growth of broiler chicken exposed to high ambient temperature have recently been reported (Daghir, 1995). Exposure to heat stress within short period could enhance and promote immunity but this has also been reported to bring about damages if prolonged (Dhabhar and Mcewen, 1997). Intense feed restriction (FR) was reported to cause shorter lifespan and this depends on genotype or breed of chicken (Forster *et al*., 2010).

Feed restriction should be carried out with care as it could be advantageous when mild (Badmus *et al*., 2022) and dangerous when severe. Study conducted within a regulated climatic condition indicated that FR early in life improved the ability of chickens to adapt with rigors of high temperature as compared to their cohort that were fed ad lib throughout the study (Zulkifli *et al*., 1994; 2000). It should, therefore, be noted that under rigorous feed deprivation, there could be reduced body weight (Daghir, 1995) resulting from discrepancy in the metabolic activities leading to oxidative damages (Sharma *et al*., 2012; Von Zglinicki, 2002). Revealing biomarkers for the assessment of animal physiology becomes imperative in the animal sectors. Haematological and biochemical values and plasma corticosterone still remain one of the conventional biological indicators for monitoring animal physiological responses (Mashaly *et al*., 1984) and are identified as the most commonly employed (De Jong *et al*., 2002). Adaptability and resiliency of chicken to heat stress could be breed or strain specific. Local and slow growing chickens are known to adapt and shown more resiliency to heat stress than their counterpart exotic and fast-growing type. The information on how early feed restriction and strains could influence phenotypic associations and adaptive response among growth performance and blood haematological and biochemical traits is not well known and this prompted this study. Therefore, this study is aimed at unveiling the phenotypic correlations and adaptive responses among growth performance and blood parameters in two broiler strains of chicken exposed to feed restriction therapy under heat stress

MATERIALS AND METHODS

Experimental site and Management of experimental birds

The research was conducted at teaching and research farm of the Federal University Gashua. Gashua is located between Longitude 10° 02' and 11°, 11°E and Latitude 12° 48° and 12°88'N. It is situated in the Sudan Savanna ecological zone of Nigeria (NEAZDP 2015). One hundred (100) day-old broiler chicks of two different strains (Arbor Acre and Cobb^{500}) were purchased from a commercial hatchery in Jos, Plateau State, Nigeria. The chicks were brooded together for the first 14 days, during which they were fed a commercial super starter diet available in Gashua, Nigeria. The feed restricted chicken was fed 60% of the feed given to the control between days 7 to 14 of age. On the 15th day, the chicks were randomly allotted to 2 diets treatments containing 3 replications of 8 chicks per breed in a 2 x 2 factorial experiment of completely randomized design. The birds were kept in deep litter system and fed both starter and finisher diets according to their ages and vaccinated against Gomboro and New Castle diseases at 2 and 4 weeks of age respectively. At the age of 4 weeks, they were exposed to heat stress of 36 ºC for six hours per day for the period of two weeks.

Data Collection

Body weight and body conformation traits

Body weights of the chicken were measured using electronic weighing scale in grams and the body conformation traits such as body length, body girth,

shank length and drumstick length were measured using a measuring tape in centimetres.

Haematological and biochemical traits

At the end of the experiment, two birds were randomly selected from each replicate from the breeds of chicken, total of twenty-four, humanely slaughtered and their blood samples were directly collected into Ethylene-diethyl tetra acetic acid (EDTA) tubes and thereafter subjected to haematological analysis for white blood cells, red blood cells and blood platelets. Another set of blood samples were collected into plain sample bottles to obtain serum and were subjected to biochemical analysis for alkaline phosphatase, total protein and total calcium. These analyses were conducted in the State Specialist Hospital, Gashua, Yobe State.

Data Analysis

Data collected on growth performance, body conformation traits, hematological and biochemical traits were subjected to procedure of general linear model of SAS (2013). Phenotypic correlation coefficients among body weight and body conformation traits were determined by the analysis of covariance using the Pearson's correlation procedure of SAS 9.4 (2013) according to methods described byFalconer (1989). Significant differences among means were compared using the Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

The result in Table 1 showed the effect of breed and feed restriction on growth and body conformation traits. There was significant ($P < 0.05$) difference in the body weight of feed restricted chicken and control in both the Arbor Acre and Cobb^{500} breeds of chicken with birds under feed restriction having lower body weights. The interaction between the feed restriction and the breed was significant ($P<0.05$). However, significant ($P < 0.05$) effect of breed was not found on the body weight of the chicken used in this study. Moreover, no significant ($P > 0.05$) effects of breed, feeding and interaction between feeding and breed were found on the body length, shank length and the drumstick length of the chicken used in this study.

The results revealed that breed did not have any influence on body weight, body girth, shank length and drumstick length. This showed that performances of Arbor Acre and Cobb chickens are same under the temperatures of this study. And this is an indication that Arbor Acre and Cobb 500 might have the same adaptive strength to heat stress. Broiler flocks may become non-uniform as a result of temperature changes, whether high or low, that deviate from the comfort zone. Broiler tolerance to temperature changes outside of their comfort range is directly impacted by a number of characteristics, including as age, sex, breed, weight, activity level, molting, broodiness, feeding, and the surrounding environment (Farag and Alagawany, 2018; Kumar *et al*., 2021). In a research conducted on Marshall, Cobb, Ross and Arbor Acre broiler chickens to test their adaptability, it was reported that all breeds revealed no noticeable variations in growth performance and morphometric traits during rainy season (Samson *et al*., 2024). Meanwhile, effects breeds on growth performance and morphometric characteristics were observed during the dry season (Samson *et al*., 2024).

Table 1: Effect of breed and feed restriction on growth and body conformation traits of two breeds of broiler chickens

		Body weight	Body length	Body girth	Shank length	Drumstick length
Arbor Acre	FR	1.78^{b}±0.18	27.87±0.74	31.75^{b}±1.56	10.50±0.51	13.41±0.50
	Control	1.83^{a}±0.22	28.12±0.94	32.37^{a}±1.55	10.54±0.50	13.54±0.58
Cobb	FR	1.71^{b}±0.19	27.94±0.74	30.94^{b}±0.96	10.64±0.49	13.58±0.50
	Control	1.92^{a}±0.13	28.17±0.21	32.69^{a}±1.22	10.69±0.47	13.60±0.49
P-Value	Breed	0.80	0.66	0.41	0.16	0.29
	Feeding	0.01	0.16	0.00	0.62	0.52
	Breed x Feeding	0.04	0.96	0.66	0.97	0.64

P-Value = Probability value

The results of the correlations among body weight and body conformation traits of Arbor Acre and Cobb^{500} chicken breeds were revealed in Tables 2 and 3. In Arbor Acre, the results showed that body weight had significant and positively high correlations with body length ($r=0.807$, $P < 0.001$), body girth ($r=0.832$, $P < 0.001$), shank length ($r=0.551$, $P < 0.01$) and drumstick length ($r=0.729$, $P < 0.001$) in Arbor Acre. The correlations among body conformation traits were found to be significant and positively high ranging from $r=0.568$ to 0.893 with P-values of either 0.01 or 0.001. The

same correlation patterns both in magnitude and direction were obtained in Cobb[500] breed of chicken. The correlation coefficient in this study revealed that body weight and body conformation traits are strongly associated body conformation traits could be used as predictors for growth performance of the chickens under study especially in the absence of scales.

The most direct way to determine broiler's mass is to weigh it using digital weighing scale. However, under some circumstances, a scale may not be available and alternative is to measure a body part and relate the measurement to the body weight. Shank length, thigh length, breast width are some body parts that are commonly measured and related to body weight in poultry (Nwagu *et al.,* 2009; Kabir *et al.,* 2010). Some basic measurements such as breast width, thigh length and weight, and shank length, has been ascribed that they are serving as essential indicators and revealing a positive association with live body weight (Nosike *et al*., 2017). Using these measurements in selective breeding programs to attain larger breast sizes, has yielded great improvements (Ukwu *et al*., 2014).

Table 2: Phenotypic correlation coefficient among body weight and body conformation traits in Arbor Acre Broiler chicken

Parameters	Body Weight	Body Length	Body girth	Shank Length
Body Length	0.807***			
Body girth	0.832***	0.893***		
Shank Length	0.551**	0.568**	0.622**	
Drumstick length	0.729***	0.707***	0.765***	0.825***

**= P < 0.01, ***= P < 0.001

Table 3: Phenotypic correlation coefficient among bod weight and body conformation traits in Cobb[500] Broiler chicken

Parameters	Body Weight	Body Length	Body girth	Shank Length
Body Length	0.806***			
Body girth	0.832***	0.893***		
Shank Length	0.550**	0.568**	0.622**	
Drumstick length	0.729***	0.707***	0.765***	0.825***

**= P < 0.01, ***= P < 0.001

The results of effects of breed, feeding and interaction between breed and feeding on hematological parameters were revealed in table 4. No significant (P > 0.05) effects of breed, feeding and interaction between breed and feeding were obtained in white blood cell (WBC), platelet (PLT), red blood cells (RBC), total protein (TP) and total calcium (TCALC). Meanwhile, significant (P < 0.05) effect of breed was found on alkaline phosphatase (ALP). there were no significant (P > 0.05) effects of feeding and interaction effect between feeding and breed on serum alkaline phosphatase (ALP). The outcome of the hematological and biochemical results in this study revealed that was ALP was altered by breed and this implied that Cobb broiler chicken could perform better in terms of body mass, meat and general well-being. Research generally supports the claim that, although heat stress does impact broiler chickens' haematological and biochemical markers, the precise alterations may not differ substantially among strains. Heat stress, for instance, has been shown in certain studies to reduce specific white blood cell types and other haematological and biochemical values, albeit these alterations might not be uniform among strains. Similar to this, heat stress may have an impact on biological measures such as serum protein levels, however the degree of these changes may not differ substantially throughout broiler strains. However, Yongjie *et al*. (2018) noticed wide variations in corticosterone, leucocytes and HSP70 transcription levels in WRR and LS broiler breeds.

Table 4: Effects of breeds and feed restriction on hematological and biochemical parameters of two broiler breeds of chickens under heat stress

		WBC	PLT	RBC	ALP	TP	T. CALC
Arbor	FR	68.53 ± 6.70	23.67 ± 5.20	2.30 ± 0.15	102.33 ± 1.76	59.67 ± 19.74	2.76 ± 0.09
Acre	Control	79.57 ± 1.16	21.73 ± 4.91	2.60 ± 0.06	101.00 ± 3.21	58.33 ± 18.34	2.60 ± 0.21
Cobb	FR	73.60 ± 7.50	26.67 ± 5.70	2.13 ± 0.35	108. 00 ± 1.53	40.67 ± 0.83	2.67 ± 0.34
	Control	66.73 ± 7.55	34.33 ± 5.36	2.27 ± 0.24	106. 00 ± 2.08	40.00 ± 1.00	2.50 ± 0.06
P-Value	Breed	0.30	0.17	0.30	0.04	0.20	0.64
	Feeding	0.39	0.63	0.37	0.48	0.94	0.44
	Breed x Feeding	0.94	0.37	072	0.89	0.98	1.00

WBC = White Blood cells; PLT = Plateletes; RBC = Red Blood cells; ALP = Alkaline Phosphatase; TP = Total Protein; T. CALC = Total Calcium

CONCLUSION

Regardless of feeding schedule, it is observed that Arbor Acre and Cobb could both adapt to heat stress in the same manner. There is a strong genetic relationship and association between body weight and body conformation traits and they can be used to develop models of predicting body weight.

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