# THERMO-TOLERANCE OF TWO BREEDS OF COMMERCIAL BROILER CHICKENS USING THE HETEROPHIL-LYMPHOCYTE RATIO

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**ABSTRACT**
*Two hundred and thirty-two (232) four weeks old broiler chickens were housed in two separate pens of 116 birds (52 Cobb 500 and 64 Ross 308) per pen in a split-plot experimental design. Each breed served as a treatment that was replicated 4 times, with 13 Cobb 500 and 16 Ross 308 chickens per replicate. The two pens were labelled controlled (40±1ºC) and natural (32.54ºC) heat-stress pens. Controlled heat stress was induced throughout the experiment (4 to 8 weeks of age) by increasing the temperature of the pen to 40 ± 1°C for four hours daily (11:00am to 3:00pm). The controlled heat stress condition that was applied in this study was an attempt to mimic the increase in atmospheric temperature that is expected in the next seven decades in the study area due to climate change. Haematological traits measured included Heterophils (H), Lymphocytes (L) and Heterophils-Lymphocytes ratio (H:L). Data obtained were analyzed using the General Linear Model procedure of Statistical Analysis System and means separated by Tukey Test. Significant ($p<0.05$) breed differences were observed for H, L and H:L with Cobb 500 having the lowest and the best values for H:L in both the natural (0.52) and controlled (0.80) heat stress condition. The results of this study showed better thermo-tolerance of Cobb 500 chickens compared to Ross 308 across the heat stress conditions as it recorded lower values for H:L. Therefore, Cobb 500 is the most suitable breed for rearing till 8 weeks of age under the present-day climatic extremes (heat stress) and that of the next seven decades.*
**Keywords: Thermo-tolerance, Heterophils, Lymphocytes, Heterophils-Lymphocytes ratio, Heat stress, Broiler chickens**.

## INTRODUCTION

Thermo-tolerance is the ability of broiler chickens to maintain the expression of their genetic potential when raised under heat stress (Razuki, 2016). Heat stress has been associated with considerable reduction in feed intake, body weight, livability and increase susceptibility of broiler chickens to infections and diseases which has a serious impact on the cost of production (Slimen *et al.,* 2016). All these potentially threaten to impoverish farmers (especially smallholder farmers) reliance on broiler production thereby posing a potential threat to Nigeria's food security.

To combat this challenge, several research efforts have been made on the use of supplemental vitamins (Li *et al*., 2021), electrolytes (Wasti *et al*., 2021), probiotics (Adewole and Oladokun, 2020), prebiotics (Mohammed *et al*., 2019) and organic acids (Uyanga *et al*., 2023) in ameliorating the effect of heat stress in broiler chickens. While some of these studies have obtained promising results, the solutions they provide are limited and useful only for the short-term as a result of the ever increasing temperature associated with climate change (Saeed *et al*., 2019). Thus, it was hypothesized that the long-term strategy for arresting the attendant menace of heat stress in the tropics is the choice of broiler chickens that are genetically thermo-tolerant using the heterophils-lymphocytes ratio (H:L) as an index. The H:L has been shown to be highly heritable (Al-Murrani *et al*., 2006) and a reliable index for determining stress in poultry (Ajakaiye *et al.*, 2010). The H:L ratios of 0.2, 0.5 and 0.8 have been suggested as indicators of no stress, moderate and severe stress in Chickens (Al-Murrani *et al*., 2006). A high ratio is negatively correlated with body weight and positively correlated with mortality (Bezerra *et al*. 2017). The aim of this study was to evaluate the thermo-tolerance of Ross 308 and Cobb 500 broiler chickens subjected to diurnal heat stress using the H:L ratio as an index.

## MATERIALS AND METHODS

### Experimental site

The experiment was conducted at the Poultry Unit of the Departmental of Animal Science Teaching and Research farm, Ahmadu Bello University, Zaria, Kaduna State, Nigeria. Zaria is located in the Northern Guinea Savannah Ecological zone on longitude 11° 09' 01.78'' N and latitude 7°39' 14.79'' E 671m above sea level. The climate is characterized by well-defined dry and wet seasons with an annual range rainfall of 700-1400mm (Ovimaps, 2023).

**Experimental Design and heat stress conditions**

Two hundred and thirty-two (232) four weeks old broiler chickens were housed in two separate pens of 116 birds per pen comprising 52 each of Cobb 500 and 64 Ross 308 breeds in a split-plot experimental design with temperature set as the main plot and breed set as the subplot. Each breed served as a treatment that was replicated 4 times, with 13 Cobb 500 and 16 Ross 308 chickens per replicate. The two pens were labelled controlled (40 ± 1°C) and natural (32.54ºC) heat-stress pens. Controlled heat stress was induced throughout the experiment by increasing the temperature of the pen to 40 ± 1°C for four hours daily (11:00am to 3:00pm) using a digital automatic temperature regulatory system (2000w) that was designed for the purpose of the study comprising of light bulbs (200w), thermostat (White Rodgers, P200, USA), thermal Censor (Ulanet™, IN812-372-0281, USA) and blowing fans. The digital automatic temperature regulatory system was powered by a Generator (Tiger, 2800w, China). The controlled heat stress condition that was applied in this study was an attempt to mimic the increase in atmospheric temperature that is expected in the next seven decades in the study area due to climate change (Duangjida *et al.,* 2017)

The statistical model for this experiment during the starter phase is given below:

$Y_{ij} = \mu + T_i + B_j + e_{ij}$

Where:

$Y_{ij}$ = Observations as influenced by the random effect of $i^{th}$ temperature and the fixed effect of $j^{th}$ breed.

$\mu$ = overall mean.

$T_i$ = random effect of $i^{th}$ temperature (j = 2)

$B_j$ = fixed effect of $j^{th}$ breed (i = 2).

$e_{ij}$ = random error (which is assumed to be identically independent and normally distributed with zero means and constant variance).

**Management of birds**

The birds were housed in deep litter pens. Feed and water were provided *ad libitum* for the birds throughout the 28 days period of the experiment.

**Haematological assay**

Blood samples (1.5mls) were collected from eight birds that were randomly selected from each of the genetic group via the brachial vein using 5mls sterile disposable syringes and needles (21 gauge) and emptied into sterile sample bottles containing Ethylene Diamine Tetra Acetic acid (EDTA) as anti-coagulant on the 28th day of the experiment for haematological assay. The samples were analysed at the Clinical Pathology Laboratory of the Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria. The samples were analysed for H, L and H:L as described by Gross and Siegel (1983)

**Statistical analysis**

All data obtained from this experiment were statistically analysed using the General Linear Model procedure of Statistical Analysis Systems software package version 9.1 (2002). Significant differences between treatments means were separated using Tukey Test of the same statistical package.

**RESULTS AND DISCUSSION**

The least square means for breed variation in Haematological traits of broiler chickens at 8 weeks of age raised under heat stress conditions, is shown in table 1.

**Table 1: Breed Variation in Heterophil, Lymphocyte and Heterophils Lymphocytes ratios of broiler Chickens at 8 weeks of age raised under heat stress conditions.**

| | Controlled Heat Stress (40 ± 1ºC) | | | Natural Heat Stress (32.54ºC) | | |
|---|---|---|---|---|---|---|
| | Breeds | | | Breeds | | |
| Traits | Cobb 500 | Ross 308 | SEM | Cobb 500 | Ross 308 | SEM |
| H (%) | 40.80[b] | 49.05[a] | 0.45 | 34.97 [b] | 36.50[a] | 0.62 |
| L (%) | 50.75[b] | 52.34[a] | 0.37 | 67.35[a] | 61.05[b] | 1.18 |
| H:L | 0.80[b] | 0.94[a] | 0.02 | 0.52[a] | 0.60[b] | 0.01 |

[a,b], Means with different superscripts on the same row are significantly different(P<0.05), H= Heterophils, L = Lymphocytes, H:L = Heterophils-Lymphocytes ratio, Reference value (Gross and Siegel, (1983).

Significant (p< 0.05) differences were observed for all the Haematological traits across the heat stress conditions. Ross 308 had higher (p<0.05) H:L across the heat stress conditions (0.94 for controlled heat stress and 0.60 for natural heat stress). The H:L ratio has been shown to be highly heritable (Al-Murrani *et al*., 2006) and a reliable index for determining heat stress in broiler chickens (Ajakaiye *et al.*, 2010; Scanes, 2016). H:L ratios of 0.2, 0.5 and 0.8 have been suggested as indicators of no stress, moderate and severe stress in Chickens (Al-Murrani *et al*., 2006). According to this criterion, Cobb 500 chickens in this study were moderately stressed under the natural heat stress condition and severely stressed under the controlled heat stress condition while Ross 308 were severely stressed under both the natural and controlled heat stress conditions. The increase in H:L with increase in ambient temperature recorded in this study could be explained by the simultaneous increase in heterophils and decrease in lymphocytes in response to glucocorticoid hormones (stress hormones), which promote the release of heterophils from the bone marrow into the blood (Bezerra *et al*. 2017).

## CONCLUSION AND RECOMMENDATION

The results of this study showed better thermo-tolerance of Cobb 500 chickens compared to Ross 308 across the heat stress conditions as it recorded lower values for H:L.Therefore, Cobb 500 is the most suitable breed for rearing till 8 weeks of age under the present-day climatic extremes (heat stress) and that of the next seven decades.

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