THERMOREGULATORY RESPONSES OF HEAT-STRESSED BROILER CHICKENS FED A-LIPOIC ACID

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ABSTRACT
A study was carried out to investigate the effect of alpha-lipoic acid (α-LA) on thermoregulatory indices of heat-stressed broiler chickens. Two hundred and four (204) unsexed day-old Arbor acre chicks were randomly assigned to four treatment groups to receive α-LA at 0, 50, 100 and 200 mg/kg respectively in a completely randomized design (CRD) for a period of 42 days after a one-week adjustment period. Average room morning and afternoon temperatures were 27.9oC and 35.1oc respectively, while the morning and afternoon humidities were 73.1% and 44.1% respectively. Feed and water were provided ad libitum. Average Temperature-Humidity-Index (THI) indicated the presence of very severe heat stress in the afternoons (33.4). Thermoregulatory indices (respiratory rate and body temperature) were significantly (p<0.05) affected by α-LA with birds on 100 and 200mg/kg α-LA having lover respiratory rates and body temperature compared to the other groups. It was concluded that, α-LA had ameliorative effect on thermoregulation of heat-stressed broiler chickens.
Keywords: lipoic acid; heat stress; thermoregulation; broilers; temperature-humidity-index

INTRODUCTION

Stress has been defined as the sum of all biologic reactions to physical, emotional, or mental stimuli that disturb an individual's homeostasis. Stressor can be defined as any internal or external stimuli or threat that disrupts homeostasis of the body, and elicits a coordinated physiological response within the body in an attempt to re-establish homeostasis (Asres and Amha, 2014).

With the increased severity of global warming (Stillman, 2019), heat stress has become an increasingly prevalent environmental stressor that threatens human and animals health (Chauhan *et al.,* 2021), and it occurs when body heat production exceeds the heat lost to surrounding environment. Modern commercial broilers are especially vulnerable to heat stress under high ambient temperature, owing to their restrictive heat loss capacity, high metabolic rates, high heat production, hypoplasia of sweat gland, and intensive genetic selection (Nawab *et al.,* 2018). When animals are subjected to heat stress, they respond by increasing respiration rate and rectal temperature; in addition, panting, slowed heart rate, and profuse sweating are observed as well as reduced feed intake (Dimov *et al.,* 2020).

Poultry manage and maintain their body temperature by balancing metabolic heat production and dissipation during changes in environmental conditions. Several factors such as extreme heat, climate changes, temperature punctuations, and increased moisture levels lead to heat stress in poultry (Yahav, 2015). Poultry develop and adopt certain morphological, physiological and behavioural traits under heat stress conditions to maintain their normal body temperature. Poultry are said to be under heat stress conditions during an imbalance between body thermo-genesis and heat dissipation **(**Ahmad *et al.,* 2022**)**.

Alpha lipoic acid (α-LA), especially in recent years, has been used as a food additive, in order to give beneficial effects in the management and treatment of various types of disorders, such as: endothelial dysfunction, atherosclerosis, diabetes mellitus, degenerative diseases and others (El Barky *et al.,* 2017). α-LA scavenges reactive oxygen species and increase endogenous antioxidants, it is also a good chelating agent for metals in organisms and a reducing agent for the oxidized form of glutathione and vitamins C and E (Tripathi *et al., 2023*). α-Lipoic acid enantiomers and its reduced form have antioxidant, cognitive, cardiovascular, detoxifying, anti-aging, dietary supplement, anti-cancer, neuro-protective, anti-diabetic, antimicrobial, and anti-inflammatory properties (Tripathi *et al., 2023*).

MATERIALS AND METHODS

Two hundred and four (204) unsexed day-old Abor acres broiler chicks were purchased from CHI farms Ibadan, Nigeria for the study. The birds were randomly allocated to four (4) dietary treatments with fifty-one (51) birds per treatment with each treatment replicated three (3) times with seventeen (17) birds per replicate in a Completely Randomized Design (CRD). The birds were raised on deep litter system in two phases; starter (week 0 – 4) and finisher (week 5 – 7). Indoor temperature and relative humidity readings were recorded daily using an electronic digital thermo-hygrometer (HTC-1). Both readings were taken in the mornings (8.00 am) and afternoons (3.00 pm) throughout the experimental period and used to calculate the morning and afternoon THIs. Individual temperatures and respiratory rates were also measured using an infrared digital thermometer and counting of respiration (breath/minute) with the aid of a stopwatch, respectively. Temperature-humidity index (THI) is calculated using the formular of Tao and Xin (2003).

$$THI = 0.85\, T_{db} + 0.15\, T_{wb}$$

Where;

THI = temperature-humidity index in °C

T_{db} = dry-bulb or ambient temperature in °C

T_{wb} = wet-bulb temperature in °C

Wet bulb temperature was determined from ambient temperature and relative humidity using the empirical expression functions by Stull (2011).

Heat stress was classified as: absence of heat stress (<27.8), moderate heat stress (27.8 -28.8), severe heat stress (28.9 -29.9) and very severe heat stress (>30.0) (Marai et al., 2001).

The data collected from the experiment were subjected to analysis of variance (ANOVA) using the General Linear Model Procedure of JMP (2012). Where the result of ANOVA was statistically significant, Tukey post-hoc test for multiple comparisons was performed to compare means of all groups.

RESULTS AND DISCUSSION

Result showing the Temperature-Humidity-Index (THI) is shown in Fig. 1; indicating that mean THI was higher in the afternoon than in the morning. THI incorporates the effect of both temperature and relative humidity and is commonly used to quantify the degree of heat stress on animals. The birds experienced no heat stress in the mornings (23.8) and severe heat stress in the afternoons (33.4) (Marai et al., 2001) during the period of the study.

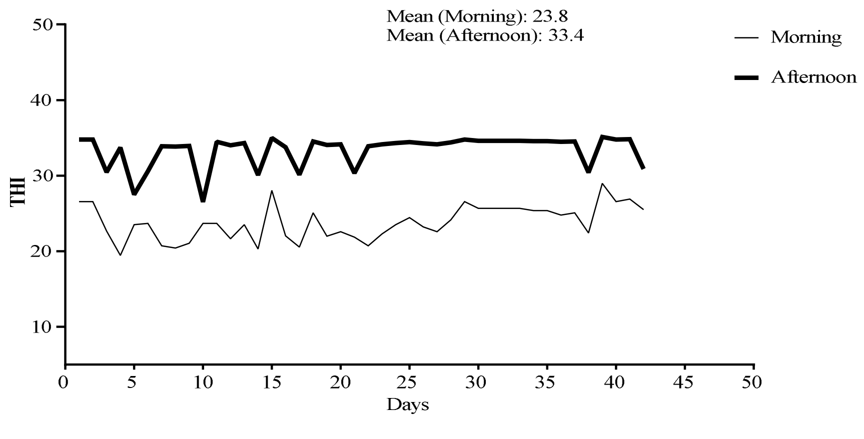

Figure 1: Daily Temperature-humidity index inside the poultry house during the experimental period

Effect of α-lipoic acid on respiratory rate and body temperatures of broiler chickens is shown in Fig 2 and 3 respectively. There were reductions in respiratory rates and body temperatures ($P<0.05$) with increasing levels of α-LA. Birds receiving 100 and 200 mg A-LA had similar respiratory rates and body temperatures and differed ($P<0.05$) from birds in the control group. Birds in the 50 mg group remained comparable ($P>0.05$) with birds in the control group. Respiratory rate and body temperature are the most important physiological markers to look out for animals under heat stress. Higher respiratory rates were observed in the control and 50 mg/kg α-LA, indicative of heat stress in the group. Poultry under heat stress conditions develop and adopt certain morphological, physiological and behavioural traits such as panting, increasing respiration rate and slowed heart rate to maintain their normal body temperature (Dimov *et al.*, 2020; Ahmad *et al.*, 2022). Panting is the key procedure acquired by poultry birds to undergo heat loss during heat stress conditions, which brought about the increase in respiratory rate and body temperature in the control. Evaporative cooling is accomplished by increasing the respiratory rate (Toyomizu *et al.*, 2008; Renaudeau *et al.,* 2011) also known as panting and this can lead to respiratory alkalosis (Imik et al., 2013). Unfavourable temperatures such as high temperature leads to an increase heat production by the animal that is, there is more loss of energy, and in consequence less energy remains for production at the same level of energy intake, and the efficiency of energy utilization deteriorate. Broiler chickens exposed to high temperature and relative humidity find it difficult to maintain their core body temperature. Hot humid environments reduce the opportunity for heat loss through sensible and evaporative means (Widowski, 2010).

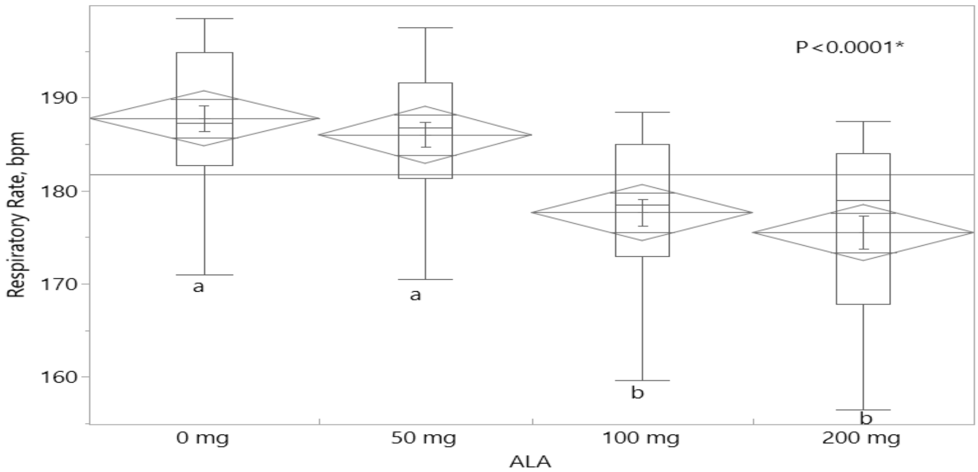

Fig. 2: Respiratory Rate of Heat-stressed broiler chickens fed *α*-LA

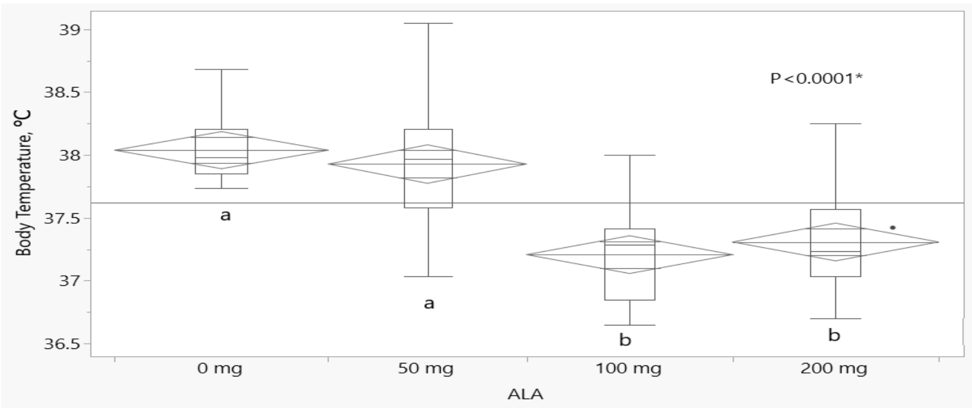

Fig. 3: Body temperature of Heat-stressed broiler chickens fed α-LA

CONCLUSION AND RECOMMENDATION

The findings of the present study indicated that supplementation of α-lipoic acid had beneficial effect on thermoregulation (respiratory rate and body temperature) of heat-stressed broiler chickens at 100 and 200 mg/kg. 100 mg/kg α-LA is recommended for thermoregulatory measures in broiler chickens.

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