EVALUATION OF THE MODULATORY ROLE OF SUPPLEMENTAL TAURINE ON RHYTHM OF CLOACAL TEMPERATURE IN BROILER CHICKENS DURING HOT-DRY SEASON.

Harold Kuta Makeri[*], Joseph Olusegun Ayo[‡], Tagang Aluwong[‡] and Ndazo Salka Minka[*]

[*] Division of Agricultural Colleges, Department of Animal Health and Husbandry, College of Agriculture and Animal Science, Ahmadu Bello University, Mando-Kaduna, Nigeria
[‡] Faculty of Veterinary Medicine, Department of Physiology, Ahmadu Bello University, Zaria, Nigeria.
Corresponding author: Harold Kuta Makeri, +2349067831084, +2348089288150, kutamakeri@gmail.com, mhkuta@abu.edu.ng

ABSTRACT

An experiment was designed to study the modulatory effect of supplemental taurine on rhythm of cloacal temperature in male broiler chickens of different ages during the hot-dry season. Twenty, 21-day old Arbor Acre male broiler chickens balanced for weight served as subjects and were assigned ten each to control (Cgp) and treatment (Tgp) groups in a completely randomized design. The broiler chickens in the Tgp were offered drinking water supplemented with taurine at a dose rate of 0.1% and the control Cgp had access to only clean drinking water both *ad libitum* in addition to their standard diets from day 21 to 42 of the study period. Body temperatures from each group were taken from the cloacae of broiler chickens on a four-hourly basis during a 24 h period on scheduled days 28, 35 and 42. The collected data was fitted into the single cosinor application, results showed cloacal temperature (CT) exhibited clear circadian rhythmicity in both groups. Taurine significantly ($P < 0.05$) decreased the mesors of CT. The acrophases in both groups were restricted to the photophase, however, taurine advanced the acrophases of CT. It was concluded taurine modulated the rhythms of CT and this effect may ameliorate heat-stress during the hot-dry season. The results may be beneficial in combating oxidative stress in broiler chickens during this season.

Keywords: Broiler chickens, Cloacal temperature, Hot-dry season, Rhythm, Taurine,.

INTRODUCTION

Environmental cycles of light and darkness, food availability and ambient temperature (AT) influence daily rhythms of physiological parameters (Ayo *et al.*,2017). Heat stress decreases feed intake, feed conversion efficiency and productivity in poultry (Luo *et al.,* 2018).Thermal environmental factors elicit heat stress, resulting in accumulation of reactive oxygen species (ROS) in biological systems, which influences poultry productivity worldwide (Akbarian *et al.,* 2016) and in the tropics (Egbuniwe *et al.,* 2018). The hot-dry season in Northern Nigeria is characterised by high AT and high relative humidity (RH), which induce heat stress (Ayo *et al.*,2017). Taurine is a non-proteinogenic ß-aminosulphonic acid, found in tissues, which prevents ROS overload by directly inhibiting its generation within the respiratory chain (Seidel *et al.,* 2018). It plays a neuromodulator role in cardiac and brain functions (Huang *et al*., 2014). The current study aimed to determine the modulatory effects of taurine in ameliorating CT elevation as a consequence of heat stress under natural photoperiod during the hot-dry season.

MATERIALS AND METHODS

The experiment was conducted in March to May, 2020 at the College of Agriculture and Animal Science, Mando-Kaduna (11° 10/N, 07° 38/E) located in the Northern Guinea Savannah zone of Nigeria. Approval for the experimental protocol was obtained from the Institutional Animal Care and Use Committee of Ahmadu Bello University, Zaria (ABUCAUC) with approval number ABUCAUC/2021/122.

Twenty (20) 21-day-old clinically-healthy Arbor Acres hybrid male broiler chickens with similar weights, were preconditioned prior to commencement of experiment. The birds were kept on deep litter in two partitions (1,200 x 2,000 cm) of 10 birds each (Cgp and Tgp), they had access to water and standard diet (Chikun Feeds®, Olam Feeds and Flour Mills, Kaduna, Nigeria) *ad libitum* during the experimental phases. The Tgp received daily supplemental taurine (Nutricost®, 7 S 1550 W ♯ 200

Lindon, UT.84042. USA., purity 1000 mg. g^{-1}.) at a dose rate of 0.1% in drinking water *ad libitum* (Belal *et al.*,2018) and the Cgp had access to only clean drinking water *ad libitum* for 21 days of the study period. Thermo-hygrometric readings and body temperatures were recorded four-hourly from 09:00 h on day 1 to 09:00 h on day 2, on scheduled days of 28, days 35 and 42. The ambient temperature (AT) was measured using a dry and wet-bulb thermometer (DTH 1; Clarke International Ltd., Essex, UK), placed in the middle of the pen (Silanikove, 2000). The RH values were calculated using Osmon's hygrometric table (Narinda Scientific Industries® Haryana, India). The temperature-humidity index (THI) was calculated using the formula (Tao and Xin, 2003): THI= 0.85 (t_{db}) + 0.15 (*twb*); Where THI = temperature-humidity index for broiler chickens, t_{db} = dry-bulb temperature and t_{wb} = wet-bulb temperature. Cloacal temperature (CT) of the broiler chickens was measured by inserting a moistened digital thermometer (Branman, Yorkshire, England) range 32 – 42.9°C, measurement of accuracy 0.1 °C).

Data Analyses

The results were presented as mean ± SEM. Evaluation for rhythmicity by the cosinor procedure using Cosinor Online Software (Molcan, 2019). Three rhythmic parameters were characterised and determined: mesor (M) rhythm adjusted mean level, amplitude (A), acrophase (Φ) time at which peak of rhythm occurred. The mean level of the rhythm was computed as the arithmetic mean of all values in the data set. The amplitude of the value rhythm was calculated as half the maximum – minimum range of the oscillation (which was computed as the difference between the peak and trough). The difference between control, treatment groups and times of measurement were tested by two-way ANOVA. The results are presented as tables and chronograms. Values of $P < 0.05$ were considered significant.

RESULTS AND DISCUSSION

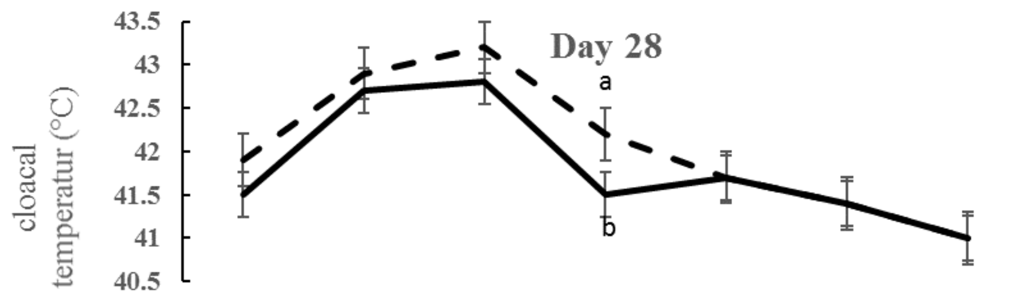
Thermal environmental data during the experimental period had the highest DBT (36.0°C), and THI (35.6 °C), these were outside the established values of 18 - 24.5°C for poultry (Donkoh, 1989). The RH was high, which suggested that the experimental period was thermally stressful and unfavourable for evaporative cooling to the broiler chickens (Minka and Ayo, 2016).

Table 1: Rhythm characteristics of cloacal temperature in taurine-supplemented male broiler chickens at days 28, 35 and 42 of experiment during the hot-dry season

Day	Groups	Mesor (°C)	Amplitude (°C)	Acrophase (h)
28:	Control	42.1 ± 0.29^a	1.0	16.8
	Treatment	41.8 ± 0.26^b	0.7	16.4
35:	Control	42.1 ± 0.25^a	0.8	17.7
	Treatment	41.6 ± 0.30^b	1.1	15.6
42:	Control	42.0 ± 0.26^a	0.8	17.7
	Treatment	41.8 ± 0.32^a	1.1	15.6

[a, b,] = Values with different superscript letters along the same row differ significantly $P < 0.05$

Rhythm characteristics of CT showed that Cgp recorded higher mesor and amplitude values (42.1 ± 0.29 and 1.0°C) on day 28 compared with Tgp, which had 41.8 ± 0.26 and 0.7°C, respectively (Table 1). On day 35, the mesor of CT in Cgp was significantly ($P < 0.05$) higher (42.1 ± 0.25 ° C) than (41.6 ± 0.30°C) in Tgp. The amplitude of CT recorded was relatively higher (1.0°C) in Cgp, compared to Tgp (0.7°C) on day 28 of study.



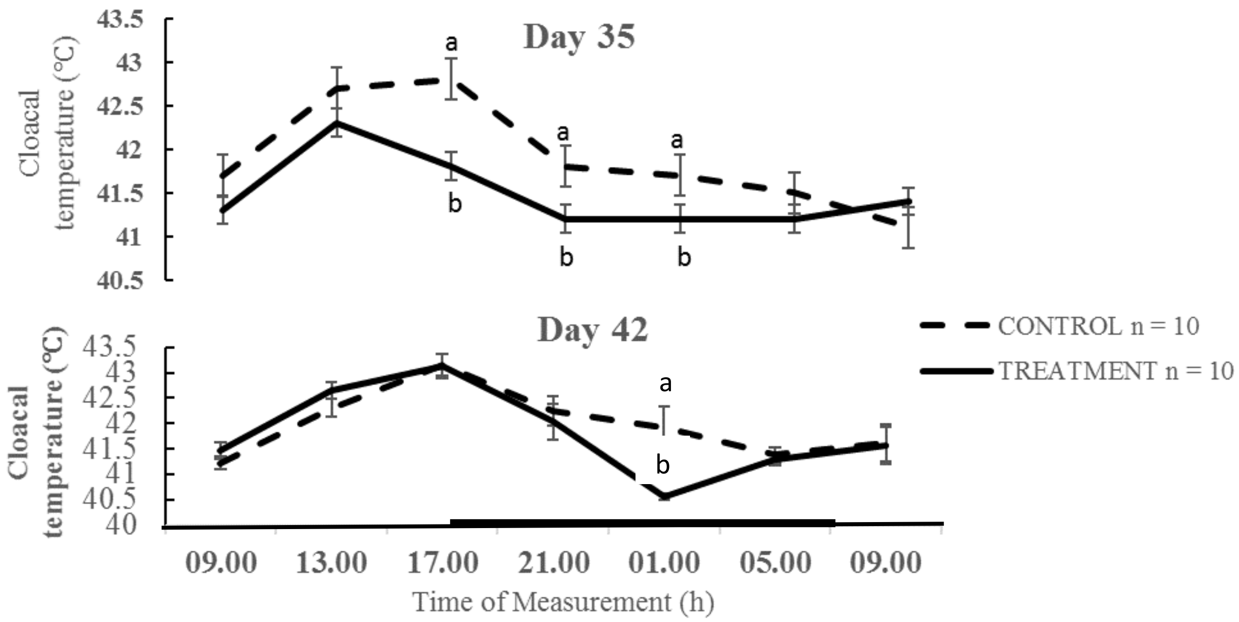


Figure 1: Diurnal variation in cloacal temperature of taurine-supplemented male broiler chickens at days 28, 35 and 42 of experiment during the hot-dry season Note: Each data point represents the Mean ± SEM of 10 broiler chickens at each period of measurement. The black horizontal bar denotes the dark phase of the prevailing light/dark cycle. [a, b] = Means with different letters are significantly ($P < 0.05$) different.

Rhythm of CT showed a clear daily rhythm in both Cgp and Tgp with acrophases that were restricted to the photophase (Figure 1). The peak AT recorded during the study period was at 17.0 h, with the minimum recorded (24.3°C) at the early photophase (09.0 – 13.0 h) and scotophase (21.0 – 09.0 h) were not thermally stressful to the broiler chickens. The Cgp had delayed acrophases (16.8, 17.1 and 17.7 h), respectively compared to the much earlier attained recorded acrophases (16.4, 15.6 and 15.6 h) in the Tgp on days 28, 35 and 42, respectively (Table 1). Homeothermy is integrated in the hypothalamus (Baarendse *et al.*, 2007), therefore, the recorded variations in CT due to increased AT in current study suggested that broiler chickens responded by adjusting body temperature (Li *et al.*, 2020). In the current study, taurine may have decreased the endogenous pyrogenes that are associated with hyperthermia, while advancing their acrophases to coincide with the hour of the day when the AT was low. Taurine modulated the upward spike in CT during the early and late hours of the day, by increasing the levels of those endogenous pyrogenes during early hours of the day in Tgp. This finding could be attributed to taurine's' thermogenic effect. The result agreed with the finding of Belal *et al.* (2018), who reported improved thermotolerance by increased HSP70 production. The advancement of the acrophase of CT which occurred before peak AT, increased the ability of the broiler chickens to maintain CT within the normal range of 40.1 - 42.0 °C. The inhibitory effect of taurine on the central nervous system, may have exerted a neuro-modulatory effect that inhibited synaptic transmission, thereby, inducing hypothermia, possibly through the central gamma amino butyric acid (GABA) receptors in the hypothalamus ((Huxtable, 1992).

Conclusion

It was concluded, taurine modulated the rhythms of CT and this effect ameliorated heat-stress during the hot-dry season. It is recommended that taurine supplementation to broiler chickens may be beneficial in combating oxidative stress in broiler chickens during the hot-dry season.

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