BETAINE HYDROCHLORIDE AMELIORATES THERMOREGULATORY RESPONSES OF BROILER CHICKENS UNDER DEXAMETHASONE INDUCED HEAT STRESS.

[1]L.A. Ademu*, [2]O.M. Daudu, [3]G.T. Iyeghe-Erakpotobor, [3]P.P. Barje, [1]J.A. Olusiyi
[1]Department of Animal Production and Health, Federal University Wukari, Taraba State, Nigeria
[2]Department of Animal Science, Ahmadu Bello University, Zaria, Kaduna State, Nigeria
[3]National Animal Production and Research Institute, Shika, Zaria Kaduna State, Nigeria
***Corresponding Author**: lawrenceademu@gmail.com*

ABSTRACT
A study was conducted to investigate the ameliorative effect of betaine hydrochloride under dexamethasone induced heat stress. A total of 300 day-old *Arbor acre* broiler chickens randomly assigned to five treatments in a completely randomized design were used in the study. The five treatments with three replicates (n= 20 birds/rep) made up of a treatment containing no dexamethasone and no betaine served as the control. Another treatment was fed 0.30% betaine only supplemented diets, with the other three treatments given daily dexamethasone concentrations at 1, 2 and 3 mg/L in water, respectively. All dexamethasone treated birds were fed 0.30% betaine HCl in their diets. Results indicated a decrease (P>0.05) in rectal temperature and respiratory rate with increasing dose of dexamethasone, especially with the betaine only group. Betaine HCl had a positive effect on thermoregulatory parameters of broiler chickens by ameliorating the negative effect of heat stress.
Keywords: Stress, Dexamethasone, Broilers, Betaine, Osomolyte

INTRODUCTION
Broiler chicken production under high ambient temperature and high relative humidity has been shown to induce heat stress (Ali *et al*., 2010). Heat stress results in the excess production of reactive oxygen species (ROS) which cause oxidative damage (Zhang *et al*., 2014). Given its similarity to endogenous corticosteroids, dexamethasone's ability to reproduce the effects of high levels of corticosterone, thus mimicking stress associated signalling pathways has been demonstrated (Eid *et al*., 2006; Aengwanich, 2007; Ademu *et al.*, 2018) A. With stress a costly problem for the broiler industry, nutritional strategies to lessen its effects are being developed. Betaine supplementation to diets for livestock has increased during the last decade (Fernandez-Figares *et al.,* 2008). Betaine, the trimethyl derivative of the amino acid glycine, is a naturally occurring compound, which is widely distributed in many plants and animal tissues. Betaine exerts an osmo-regulatory role in cells, regulating water balance, which is beneficial for alleviating physical reactions to heat stress (Ratriyanto and Mosenthin, 2018). The aim of the study was to investigate the ameliorative effect of betaine hydrochloride on the thermoregulatory responses of broiler chickens under induced heat stress conditions.

MATERIALS AND METHODS
The experiment was conducted at the Teaching and Research farm of the Department of Animal Science, Ahmadu Bello University Samaru, Zaria. Three hundred day old *Arbor acre* broiler chicks were used in the experiment. They were randomly allotted to five experimental treatments in a completely randomized design. Each treatment was replicated three times with twenty birds per replicate. A maize/soybean based broiler starter and finisher diet was formulated according to NRC (1994) nutrient requirement for broiler chickens. Birds receiving 0 mg dexamethasone and without betaine supplementation served as the control. Birds administered 1, 2 and 3 mg dexamethasone in drinking water along with a betaine only group were given diets supplemented with Betaine HCl at 0.30%. Daily doses of dexamethasone (1, 2 and 3 mg) was administered by dissolving in a litre of water and supplied for twenty-eight days beginning from when the birds attained 14 days of age.

THERMOREGULATORY MEASUREMENTS

Indoor temperature and relative humidity readings were recorded daily using an electronic digital thermo-hygrometer. Both readings were taken in the morning (8.00 am) and afternoon (3.00 pm) throughout the experimental period. Rectal temperatures and respiratory rates were measured by placing a digital thermometer in the rectum and counting of respiration (breath/minute) with the aid of a stopwatch respectively. Temperature-humidity index (THI) was 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 and
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).

DATA ANALYSIS

All data collected from the experiment was subjected to analysis of Variance (ANOVA) using the general linear model procedure of JMP (2012).Where the result of ANOVA was statistically significant, test for multiple comparisons was performed to compare means of all groups using Tukey (1949).

RESULTS AND DISCUSSION

The average temperature humidity index (THI) inside the poultry house during the experimental period for mornings and afternoons is shown in Figure 1. THI in the afternoons were 25.4% higher than in the mornings indicating the absence of heat stress in the morning and the presence of very severe heat stress in the afternoon. Tao and Zin (2003) also observed that the body temperature of broilers tends to rise at THI 30.0.

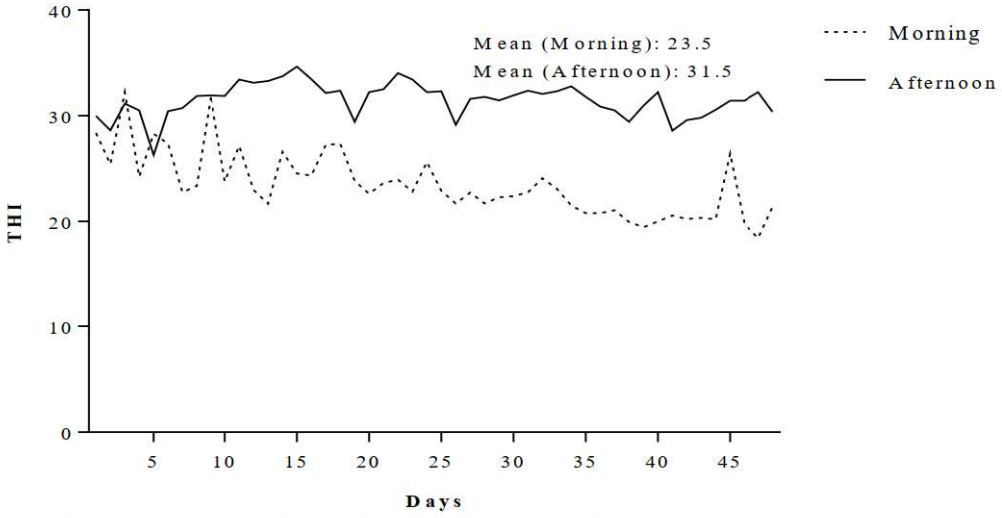

Figure 1: Daily Temperature-humidity index inside the poultry house during the experimental period

The effect of betaine HCl on rectal temperature of broiler chickens **under** dexamethasone **induced stress** is shown in Figure 2. A decrease in rectal temperature with increasing doses of dexamethasone was observed. Birds in the betaine only group had the lowest rectal temperature compared to other treatment groups. This result is supported by Hassan *et al*. (2011) and Nofal *et al*. (2015) who concluded that betaine supplementation in diets reduced rectal temperature. As an osmolyte, betaine may have a stabilizing function on cells subjected to osmotic stressors (Klasing *et al.,* (2002) by

regulating the water balance, resulting in the stability of tissue metabolism especially in the gastrointestinal tract (Lipinski *et al.,* 2012), protecting them from heat shock.

The respiratory rate (Figure 3) across the treatment groups was not significant (P>0.05). However, a decrease in respiratory rate with increasing dose of dexamethasone was observed. Birds in the betaine only group had the lowest respiratory rate. One of the visible symptoms of a bird under heat stress is panting or increased respiratory rate (Etches *et al.,*2008)When the environmental temperature exceeds the comfort limit, chickens suffer heat related stress resulting in physiological and metabolic changes (Borges *et al.,* (2007).

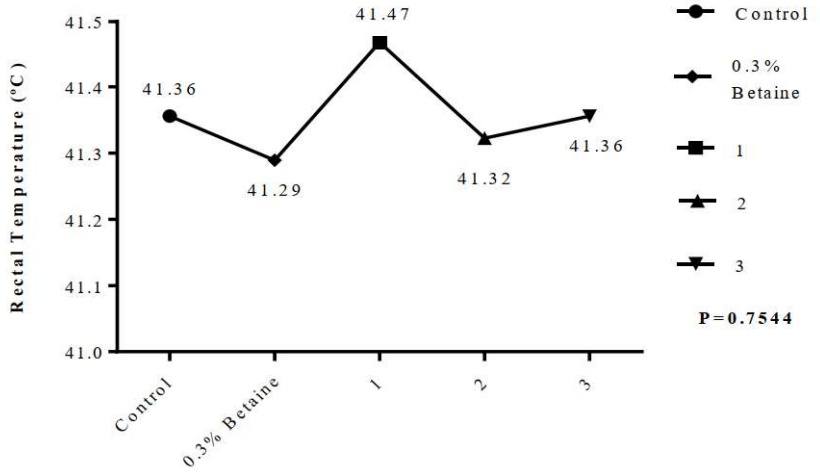

Figure 2: Effect of 0.30% Betaine HCl on Rectal Temperature of Dexamethasone Stress-induced Broiler Chickens

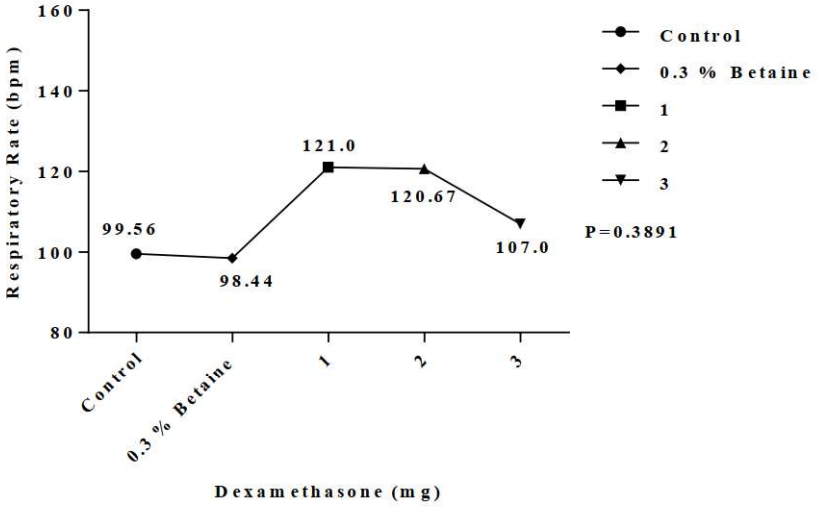

Figure 3: Effect of 0.30% Betaine HCl on Respiratory Rate of Dexamethasone Stress-induced Broiler Chickens

This study also agrees with Aengwanich (2007) who administered dexamethasone at 1-5 mg/kg to broiler chickens. Respiratory rate was found to be reduced even below that of the control group for the betaine only group indicating the ameliorative effect of betaine.

CONCLUSION

The supplementation of betaine HCl in broiler chicken diets had an ameliorative effect on thermoregulatory parameters of broiler chickens.

REFERENCES

Ademu, L.A., Iyeghe-Erakpotobor, G.T., Barje, P.P., Daudu, O.M. and R. J. Wafar (2018). Response of Broiler Chickens under Dexamethasone Induced Stress Conditions. *Asian Journal of Research in Animal and Veterinary Sciences,* 1(1): 1-9, 2018; Article no.AJRAVS.39782

Aengwanich, W. (2007). Effects of Dexamethasone on Physiological Changes and Productive Performance in Broilers. *Asian Journal of Animal and Veterinary Advances,* 2: 157-161.

Borges, S.A., Da Silva, A.V.F. and Maiorka, A. (2007). 'Acid-base balance in broilers'. *World's Poultry Science Journal*, 63(1): 73-81.

Ali, M.N., Qota, E.M.A. and Hassan, R.A. (2010). Recovery from adverse effects of heat stress on slow-growing chicks using natural antioxidants without or with sulphate. *Int J. Poult. Sci*. 9(2):109–117.

Devenport, L., Knehans, A., Sundstrom, A. and Thomas, T. (1989). Corticosterone's dual metabolic actions. *Life Sciences*, 45(15): 1389–1396.

Eid Y., Ebeid T. and Younis H. (2006). Vitamin E Supplementation Reduces Dexamethasone–induced Oxidative Stress in Chicken Semen. *British Poultry Science,* 47, 350 – 356.

Etches, R.J, John, T.M. and Gibbins, A.M.V. (2008) 'Behavioural, physiological, neuroendocrine and molecular responses to heat stress', in Daghir, N.J. (ed.) *Poultry Production in Hot Climate.* Second edition. Wallingford, UK: CAB international, pp. 31-66.

Fernandez-Figares, I., J. A. Conde-Aguilera, R. Nieto, M. Lachica and J. F. Aguilera (2008). Synergistic effects of betaine and conjugated linoleic acid on growth and carcass composition of growing Iberian pigs. *Journal of Animal Science*, 86: 102-111.

Hassan. R.H., Ebeid, T.A., Abd El-Lateif, A.I. and Ismail. N.B. (2011). Effect of dietary betaine supplementation on growth, carcass and immunity of New Zealand White rabbits under high ambient temperature. *Livestock Science*, 135: 103-109.

JMP® (2012) Software Version 6.12 of the SAS System for Windows. SAS Institute, Inc., Cary, NC, USA.

Klasing, K., Adler, K., Remus, J., and Calvert, C. (2002). Dietary betaine increases intraepithelial lymphocytes in the duodenum of coccidia-infected chicks and increases functional properties of phagocytes. *Journal of Nutrition,* 132: 2274-2282.

Lipinski, K., Szrambo, E., Jerochi, H. and Matasexicius, P. (2012). Effects of betaine on energy utilization in growing pigs- a review. *Annals of Animal Science,* 12:291-300.

NRC (1994). Nutrient Requirements of Poultry (9th Ed.). National Academy Press, Washington, DC.

Nofal, M.E., Magda, A.G., Mousa, S., Doaa, M.M.Y. and Bealsh, A.M.A. (2015). Effect of dietary betaine supplementation on productive, physiological and immunological performance and carcass characteristics of growing developed chicks under the condition of heat stress. *Egyptian Journal of Poultry Science,* 35: 237-259.

Ratriyanto, A.and Mosenthin, R. (2018). Osmoregulatory function of betaine in alleviating heat stress in poultry. *J. Anim. Physiol. Anim Nutr (Berl)*, 102(6):1634-1650. doi: 10.1111/jpn.12990.

Stull, R. (2011). Wet-Bulb Temperature from Relative Humidity and Air Temperature. *Journal of applied Meteorology and Climatology,* 50: 2267- 2269.

Tao, X., Xin, H. (2003). Acute synergistic effects of air temperature, humidity and velocity on homeostasis of market–size broilers. *Transactions of the ASAE* 46(2): 491-497.

Tukey, J. (1949). Comparing Individual Means in the Analysis of Variance. Biometrics,5 (2): 99–114.

Zhang, B., Guo, X., Chen, J., Zhao, Y., Cong, X., Jiang, Z., Cao, R., Cui, K., Gao, S., Tian, W. (2014). Saikosaponin-D attenuates heat stress-induced oxidative damagein llc-pk1 cells by increasing the expression of anti-oxidant enzymes and hsp72. *Am. J. Chin. Med.* 42(5):1261–1277.