THERMOREGULATORY RESPONSE OF BROILER CHICKENS FED SUPPLEMENTAL BAOBAB (*ADANSONIA DIGITATA* L) LEAF MEAL UNDER HEAT STRESS

Abdulkadir, M. T., Olofin, A. A., Oladele, D. F. and Agboola, I. A.
Department of Animal Health and Production, Federal College of Agriculture, Akure, Ondo State
Corresponding author's email: abdulkadirmt@futa.edu.ng

ABSTRACT
The thermoregulatory response of broiler chickens fed Baobab (Adansonia digitata L) leaf meal supplementation was evaluated in a 7 weeks trial. Forty-five (45) Cobb 500 broiler chickens were used for the experiment. The birds were distributed into five (5) treatment diets in a completely randomized design and replicated three (3) times where three (3) chicks served as a replicate of each treatment diet. The five (5) dietary treatments were labelled T1 (0.00% BLM), T2 (supplemented with 0.025% BLM), T3 (supplemented with 0.05% BLM), T4 (supplemented with 0.075% BLM) and T5 (supplemented with 0.10% BLM). Data on ambient temperature, relative humidity, axillary and cloaca temperatures were taken, also faecal samples were collected for corticosterone analysis. Results showed significant differences ($p<0.05$) in the faecal corticosterone levels, birds on T5 (0.10% BLM) had the highest faecal corticosterone (1.094±0.041). The morning, afternoon and evening ambient temperature stood at 25.63±0.40°C, 33.38±0.40°C and 29.35±0.55°C respectively while the relative humidity was at 77.02±5.84%, 53.65±3.21% and 68.29±2.45% for these periods of the day. No statistical differences ($P>0.05$) were recorded for the axillary and rectal temperatures for different times of the day across the experimental groups, however, birds on T2 (0.025% BLM) had the lowest axillary (40.19±0.10°C), (40.27±0.01°C) and rectal temperature (40.47±0.11°C), (40.42±0.09°C) for morning and evening respectively and least rectal temperature (41.07±0.08°C) in the afternoon. The study thus concluded that supplementing baobab (Adansonia digitata) leaf meal in the diet of broiler chickens can help in ameliorating heat stress.
Keywords: Thermoregulation, Corticosterone, Heat stress, Ambient temperature, Broiler chickens

INTRODUCTION

An organism's capacity to maintain a consistent body temperature despite drastically fluctuating environmental temperatures is known as thermoregulation. The production of broiler chickens can be impacted by climate in both positive and negative ways. The welfare and productivity of broiler chickens depend on maintaining ideal environmental conditions, including temperature, humidity, and ventilation. The condition of the broiler house has a big impact on its health; drafts, toxic gases, and uneven temperature can weaken the birds' immune systems and cause mortality. A homeostatic mechanism called thermoregulation keeps the body's internal temperature constant in the face of environmental fluctuations (Morrison and Nakamura, 2019). It is necessary to keep the body temperature to ensure that the body's immune system and enzymes continue to function as intended. The brain (hypothalamus), skin, skeletal muscles, sweat glands, and the vascular, endocrine, and nervous systems are the main organs and organ systems that maintain thermoregulation. Afferent sensing, central control, and efferent responses are all part of the thermoregulation mechanism. The hypothalamus receives information about changes in body temperature from both peripheral and central thermoreceptors. Then, depending on what the body requires, the body reacts by using a variety of processes to either produce or dissipate heat (Tansey and Johnson, 2015).

One of the main environmental issues that has a detrimental impact on various livestock species' growth, reproduction, and productivity is heat stress (Das *et al*., 2016). When chickens are exposed to high ambient temperatures, they develop physiological, behavioral, and immune responses that negatively impact their performance and result in significant financial losses for the birds (Khan *et al*., 2003).

The baobab (Adansonia digitata L), is a multipurpose plant with a wide range of applications in sub-Saharan Africa and Western Madagascar, including food, medicine, and beverages (Diop *et al*., 2006; Gebauer *et al*., 2002). Animals and people can benefit from the baobab tree's roots, seeds, pulp, flowers, leaves, and bark, among other parts (Gebauer *et al*., 2002). According to Sidibe and Williams

(2002), the leaves have been used to treat a variety of animal illnesses as well as fever, kidney, and bladder issues, asthma, and diarrhea. The leaves and fruit pulp can be used as a febrifuge and immunological stimulant, according to DeCaluwé *et al.* (2010). The baobab leaves are a good source of vitamins, minerals, and protein, it has been observed that the presence of vitamin C in it can effectively mitigate the negative effects of temperature, particularly heat stress, which is a major factor that affects poultry. This study therefore aims to assess the ameliorative effect of baobab leaf meal on birds under high ambient temperature and relative humidity.

MATERIALS AND METHODS

Experimental Site

This study was carried out at the Federal College of Agriculture Akure, Ondo State, Nigeria, in the poultry section's experimental unit. The college is situated in the southwest of Nigeria at latitude 7.2704° N and longitude 5.2241° E. The average monthly temperature varied from 22°C in December to 32°C in February, with an average annual relative humidity of approximately 84%. The average annual rainfall was approximately 1200 mm. (Arotolu *et al*., 2015).

Experimental Animals and their Management

Forty-five broiler chickens of Cobb 500 strain were used for the experiment. The birds were assigned to five dietary treatments in a completely randomized design of three (3) replicates consisting of 3 birds each. The treatments were based on five supplemental levels of baobab leaf meal. The experimental birds were fed their respective diets throughout the experiment which spanned 7 weeks. All required routines and occasional management practices were carried out. Parameters on feed consumption and weekly weight gains were recorded.

Table 1: Gross Composition (g/100g) of the Experimental Diets

Ingredients (%)	**T1**	**T2**	**T3**	**T4**	**T5**
Maize	59.35	59.35	59.35	59.35	59.35
Wheat offal	6.00	6.00	6.00	6.00	6.00
Soyabean meal	24.00	24.00	24.00	24.00	24.00
Fish meal	3.00	3.00	3.00	3.00	3.00
Soy oil	3.00	3.00	3.00	3.00	3.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Limestone	0.50	0.50	0.50	0.50	0.50
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.30	0.30	0.30	0.30	0.30
Salt	0.30	0.30	0.30	0.30	0.30
Premix	0.30	0.30	0.30	0.30	0.30
TOTAL	100.00	100.00	100.00	100.00	100.00
BLM	0.00	0.025	0.050	0.075	0.100
Calculated analysis (% DM)					
Metabolizable Energy (kcal/kg)	3108.10				
Crude Protein	20.03				
Crude Fibre	3.17				
Lysine	1.24				
Methionine	0.66				
Calcium	0.99				

Data Collection

Ambient Temperature and Relative Humidity: The ambient temperature and relative humidity were taken with a combined digital thermometer and hygrometer at 6.00 am, 12.00 pm, and 6.00 pm (Aro and Onuoha, 2020)

Cloaca and Axillary Temperatures: Cloaca and Axillary Temperatures were taken with a digital thermometer three times weekly at 6.00 am, 12.00 pm, and 6.00 pm.

Data Analysis: All data collected were subjected to analysis of variance using the statistical package for social science (SPSS) version 25.0 of the year 2017 and the Duncan Multiple Range Test of the software was used for mean separation.

RESULTS AND DISCUSSION

The result in Table 2 showed the faecal corticosterone levels of Cobb 500 broiler chickens fed different supplemental levels of baobab (*Adansonia digitata L*) leaf meal. The result showed significant ($p<0.05$) differences across the dietary groups. Birds on T_5 (0.10% BLM) recorded the highest faecal corticosterone value while birds on recorded T_1 and T_2 recorded statistically similar ($p>0.05$) values. Analyzing corticosterone from feacal metabolite is a non-invasion technique to monitor stress hormone in small animals. In the present study, the trend was increased faecal corticosterone levels with increasing baobab leaf meal supplementation, baobab leaves have been identified to contain anti- nutritional factors such as the phytic and tannic acids which interferes with some physiological activities such as metabolism, therefore the increase on the levels of corticosterone with increasing baobab (*Adansonia digitata L*) leaf meal supplementation can be as a result of increase in the levels of these anti- nutritional factors in the diet of the birds.. There is a paucity of information on the effect of baobab (*Adansonia digitata L*) leaf meal supplementation on the faecal corticosterone of broiler chickens. Increased levels of corticosterone in birds have been associated with slower feather growth during molting and poor flight (Romero *et al.,* 2015).

Table 2: Faecal Corticosterone Levels of Cobb 500 Broiler Chickens Fed Different Supplemental Levels of Baobab (*Adansonia Digitata*) Leaf Meal (BLM).

Treatments	Faecal Corticosterone
T1	0.253 ± 0.186^{d}
T2	0.287 ± 0.049^{d}
T3	0.639 ± 0.049^{c}
T4	0.899 ± 0.060^{b}
T5	1.094 ± 0.041^{a}

a-d= means in the same column but with different superscripts are statistically ($p<0.05$) significant. T_1= diet with 0.00% BLM; T_2= diet with 0.025% BLM; T_3= diet with 0.050% BLM; T_4= diet with 0.075% BLM; T_5= diet with 0.10% BLM.

The morning, afternoon, and evening axillary and rectal temperature of Cobb 500 broiler chickens fed varied supplemental levels of Baobab (*Adansonia digitata*) Leaf Meal Supplementation is as presented in Table 3 under prevailing Ambient Temperature, Relative Humidity, and their calculated Temperature-Humidity Indices (THI). The average ambient temperature recorded in the mornings, afternoons and evenings in the course of the experiments were 25.63±0.40°C, 33.338±0.40°C and 29.35±0.55°C respectively. Studies observed that high temperature and heat stress were significantly detrimental to poultry and other livestock (Vandana *et al.,* 2020) according to Kumar *et al.* (2021), optimal ambient temperature range for broiler chickens is between 23.9°C to 26.7, thus, the results regarding the ambient temperature suggest that, while the birds were well within their comfort zones in the morning, in the afternoon and evening they were on the verge of alertness and danger. The Relative Humidity (RH) data recorded for the corresponding periods of the day stood at 77.02±5.84%, 53.65±3.21% and 68.29±2.45% for morning, afternoon and evening respectively. High humidity have been identified to promote moisture accumulation and panting which can increase internal humidity and body temperature of broiler chickens (Kirsi *et al.,* 2013). The calculated Temperature-Humidity Indices (THI) for the mornings, afternoons and evenings (24.82±0.42°C, 30.62±0.29°C and 27.85±0.45°C respectively). According to Aro and Onuoha (2020), temperature and humidity are the two climatic variables that are the precursors of thermal stress in arid zone. The Temperature-Humidity Indices (THI) is a useful tool for assessing the thermal comfort of broiler chickens (Ahmad *et al.,* 2022)

Table 3: Axillary and Cloaca Temperature of Cobb 500 Broiler Chickens Fed Different Supplemental Levels of Baobab Leaf Meal (BLM) Under Prevailing Ambient Temperature, Relative Humidity and Calculated Temperature-Humidity Indices

Treatments	ABT (□)	RH (%)	THI	AT(□)	CT(□)
		Morning			
T1	25.63±0.40	77.02±5.84	24.82±0.42	40.2±0.90	40.51±0.07
T2	25.63±0.40	77.02±5.84	24.82±0.42	40.19±0.10	40.47±0.11
T3	25.63±0.40	77.02±5.84	24.82±0.42	40.26±0.09	40.52±0.06
T4	25.63±0.40	77.02±5.84	24.82±0.42	40.29±0.09	40.48±0.08
T5	25.63±0.40	77.02±5.84	24.82±0.42	40.32±0.11	40.53±0.09
		Afternoon			
T1	33.38±0.40	53.65±3.21	30.62±0.29	40.93±0.10	41.11±0.08
T2	33.38±0.40	53.65±3.21	30.62±0.29	40.96±0.09	41.07±0.08
T3	33.38±0.40	53.65±3.21	30.62±0.29	41.01±0.11	41.27±0.08
T4	33.38±0.40	53.65±3.21	30.62±0.29	40.97±0.13	41.22±0.08
T5	33.38±0.40	53.65±3.21	30.62±0.29	41.00±0.11	41.16±0.08
		Evening			
T1	29.35±0.55	68.29±2.45	27.85±0.45	40.33±0.09	40.57±0.09
T2	29.35±0.55	68.29±2.45	27.85±0.45	40.27±0.10	40.42±0.09
T3	29.35±0.55	68.29±2.45	27.85±0.45	40.35±0.11	40.56±0.09
T4	29.35±0.55	68.29±2.45	27.85±0.45	40.47±0.09	40.51±0.09
T5	29.35±0.55	68.29±2.45	27.85±0.45	40.42±0.09	40.69±0.08

ABT = Ambient temperature; RH = Relative Humidity; THI = Temperature-Humidity Indices (THI= t – [0.31-0.31 (RH/100)(t-14.4)]); AT = Axillary Temperature; RT = Rectal Temperature; T_1 = Treatment with 0.00% BLM; T_2 = Treatment with 0.025% BLM; T_3 = Treatment with 0.05% BLM; T_4 = Treatment with 0.075% BLM; T_5 = Treatment with 0.10% BLM.

CONCLUSION AND RECOMMENDATION

From the study, it can be observed that birds on baobab (*Adansonia digitata*) leaf meal supplemented diet recorded higher faecal corticosterone values which indicates that they were more stressed than birds on the control diet but still recorded normal rectal temperature ranges of 40.6□ – 43.0□ for broiler chickens, thus, supplementation of Baobab (*Adansonia digitata*) leaf meal up to 0.10% in the diet of broiler chickens in promising in ameliorating the problem of heat stress characteristic of birds high under ambient temperature and relative humidity.

REFERENCES

Ahmad, R., Yu, Y. H., Hsiao, F. S., Su, C. H., Liu, H. C., Tobin, I., Zhang, G., and Cheng, Y. H. (2022). Influence of Heat Stress on Poultry Growth Performance, Intestinal Inflammation, and Immune Function and Potential Mitigation by Probiotics. Animals 12(17), 2297. https://doi.org/10.3390/ani12172297

Aro, S.O. and Onuoha, A.N. (2020). The influence of varied acetylsalicylic acid and sodium chloride levels on performance, cloaca and axillary temperature of Isa white cocks. Proceeding of 45th Annual Conference of Nigeria Society for Animal Production (NSAP). PP.72-75.

Arotolu, A., Awodun, M. A. and Ojeniyi, S. O. (2015). Effect of sole and combined application of animal manure and NPK fertilizers on soil physic-chemical properties and nutrient status of yam. Journal of Basic and Applied Research International 10(2), 107116.

Cano, E., J.C. Pinar Fuentes, A. Cano-Ortiz, F. Leiva Gea, J.M.H. Ighbareyeh, R.J. Quinto Canas, C.J. Pinto Gomes, G. Spampinato, S. del Rio Gonzalez, and C.M. Musarella, (2022). Bioclimatology and botanical resources for sustainable development. Natural Resources Conservation and Advances for Sustainability, Elsevier, 377-388, https://doi.org/10.1016/B978-0-12-822976-7.00015-6.

Das, R., Gocheva, V. and Hammink, R. (2016). Stress-stiffening-mediated stem cell commitment switch in soft responsive hydrogels. Nature Materials 15, 318–325 https://doi.org/10.1038/nmat4483

DeCaluwé, E., Halamová K. and Damme P. (2010): Adansonia digitata L.-a review of traditional uses, phytochemistry and pharmacology; Afrika Focus, 23, pp. 11-51

Diop, A.G, Sakho M., Dornier M., Cisse M. and Reynes M. (2006): The African baobab (Adansonia digitata L.): key features and uses of Baobab tree. Nigeria Journal of forestry, 61: 55-69.

Gebauer, J, El-Siddig, K, and Ebert, G. (2002): Baobab (Adansonia digitata L.): a review on a multipurpose tree with promising future in the Sudan. Gartenbauwissenschaft. ;67: 155-160.

Kirsi, U., Sanna, H., Jouni, N., Virpi, V., Marja-Liisa, V., Marja, J., and Ilkka, L. (2023). Environmental life cycle assessment of Finnish broiler chicken production. Focus on climate change and water scarcity impacts, Journal of Cleaner Production, 410, l2023, https://doi.org/10.1016/j.jclepro.2023.137097.

Khan, R., Naz, S.,Nikousefat, Z., Tufarelli, V., Javdani, M., Rana, N. and Laudadio, V. (2011). Effect of vitamin E in heat-stressed poultry. World's Poultry Science Journal, 67(3), 469-478.

Kumar, M., Ratwan, P., Dahiya, S.P. and Nehra, A.K. (2021). Climate change and heat stress: impact on production, reproduction and growth performance of poultry and its mitigation using genetic strategies. Journal of Thermal Biology, 97 (2021), 102867

Morrison, S. F. and Nakamura, K. (2019). Central Mechanisms for Thermoregulation. Annu Rev Physiol. 10;81:285-308

Romero, T.K., Sterol, Y.O., Ganhg, H. and Kumoe, V. (2005): Levels of coritcosterone on the feathers of poultry birds. International Journal of poultry Production.: 21(2):5-32

Sidibe, M. and Williams, J. T. (2002): Baobab. Adansonia digitata. International Centre for Underutilised Crops: Southampton, UK

Tansey, E. A. and Johnson, C. D. (2015). Recent advances in thermoregulation. Adv Physiol Educ. 39(3):139-48.

Vandana G.D., Sejian V., Lees A.M., Pragna P., Silpa M.V. and Maloney S.K. (2020). Heat stress and poultry production: impact and amelioration. International JournalofBiometeorology, 65:163-179. https://doi.org/10.1007/s00484-020-02023-7