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Thermoregulation Responses of Broiler Chickens Administered Varying Levels of *Spondias mombin* Leaf Meal Raised In Humid Tropics

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ABSTRACT

Environmental temperature is the most critical variable influencing the performance of broiler chickens in the hot humid tropical climate. *Spondias mombin* has been reported to possess several benefits including antioxidants which may alleviate the effects of heat stress on broiler chickens during the hot dry season. This study investigates the thermoregulation responses of broiler chickens fed varying levels of *Spondias mombin* leaf raised in humid tropics. One hundred- and fifty-two-day-old broiler chicks were randomly assigned to four treatments which contained 0, 3, 4 and 5g/Kg diets in a Completely Randomized Design experiment. Each treatment was replicated two times with 19 birds in each replicate. Feed and water were provided *ad libitum*. The results showed that Relative humidity values in the poultry house ranged from 22% to 92% and ambient temperature values from 23.3°C to 35.8°C with calculated THI ranging from 23.47 to 31.48. The inclusion of *Spondias mombin* leaf meal at 0%, 3%, and 5% showed a similar trend of temperature distribution. The treatment with 4% SMLM shows a deviation from this trend, with thigh temperature having the highest mean value and wing temperature having the lowest. The panting rate showed the highest mean value in T4, followed by T2, T3 and T1. From the results observed from this study, the inclusion of *Spondias mombin* leaf meal (SMLM) showed no adverse effect on the physiology of the birds.

Keywords: Chicken, physiology, *Spondias mombin*, performance, hot-dry season.

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1. INTRODUCTION

Livestock Production plays a major role in the agricultural sector in developing nations, and the livestock sector contributes 40% to the agricultural GDP (Veerasamy *et al*., 2015). Increasing environmental temperature due to global warming has severely affected the production performance of farm animals. The broiler industry is considered more vulnerable to heat stress (HS) as genetic selection for higher growth rates has enabled broilers to undergo intensive physiological and metabolic changes within a short span, which made broiler birds extra sensitive to stresses such as HS (Nawaz et al., 2021; Malila et al., 2021). Heat stress significantly impairs the growth performance of broilers, which causes serious losses to the poultry industry every year (Ali *et al*., 2023). Heat stress is a situation in which the animal body has problems dissipating excess heat due to a breakdown in maintaining homeostatic body core temperature, resulting in inadequate heat dissipation and discomfort. (Alaba *et al*.,2021).

Heat stress, a significant concern, particularly affects broiler chicken, which is vital for global meat supply in the dynamic field of poultry farming. Despite advances in breeding and management, these pressures have a negative influence on avian development, well-being, and overall health, threatening the poultry industry's long-term viability. (Oluwabunmi *et al*., 2024). Poultry farmers need to consider making adaptations now to help reduce cost, risk, and concern in the future; the industry's high and unstable input costs, which result in losses, need to incentivize manufacturers to concentrate on efficient management, welfare, and health improvements, thereby creating premium and value-added products. (Oluwabunmi *et al*., 2024). Heat stress, a significant concern, particularly affects broiler chicken, which is vital for global meat supply in the dynamic field of poultry farming.

Despite advances in breeding and management, these pressures have a negative influence on avian development, well-being, and overall health, threatening the poultry industry's long-term viability. To maintain the advancements made in poultry farming, it is crucial to make sure that broiler chicks can survive shifting environmental circumstances. Handling the different challenges that broiler chickens encounter is essential for a prosperous poultry farm. Environmental, dietary, or even internal stresses can upset these birds' delicate physiological equilibrium Elitok and Bingular, 2018. It has been realised that natural feed sources like herbs and their extracts overcome the adverse effect of heat stress on broiler performance (Mahmoud *et al*., 2014; Zeng *et al*., 2015).
Spondias mombin possess antioxidant, vitamins, C and E (Maduka *et al*., 2014).

2. MATERIALS AND METHODS

Research Location

This research was carried out at the Poultry unit of the teaching and research farm located within the University of Ibadan, Ibadan, Oyo state, Nigeria (7° 27'08" N and 3° 53'49" E, 208m).

Experimental Animals

152 intact 4-week-old Agrited Ross308 broiler birds were used for the study. The birds were assigned randomly to four dietary treatments, labelled, Treatment 1 (T1), Treatment 2 (T2), Treatment 3 (T3) and Treatment 4 (T4) having 0%, 3%, 4% and 5% levels of inclusion for

Spondias mombin leaf meal (SMLM) respectively. Thirty-eight broiler birds were assigned per treatment and each treatment had 2 replicates, each containing 19 birds.

Experimental Design
A completely randomized design was adopted for this study.

Preparation of *Spondias mombin* Leaf Meal
Fresh leaves were plucked from a *Spondias mombin* tree identified at the University of Ibadan. The plucked leaves were cleaned and then spread to be air-dried at room temperature until crisp. The spread leaves were turned occasionally to allow even drying of leaves. Thereafter, the dry leaves were ground with a Burr mill and sieved to remove chaff or unground particles.

Management of Experimental Animals
The birds were confined in concrete-floored pens with wood shavings used as bedding material. The walls of the wood-structured pens were made with wire mesh to allow for adequate ventilation. Feeders and drinkers were provided in each pen. During the adaptation phase, the experimental animals were treated with antibiotics against secondary infections and vaccinated against infectious bursal disease (gumboro) and Newcastle disease (lasota).

Data Collection
Temperature-Humidity Index (THI)
Ambient temperature and relative humidity values were recorded twice daily, in the morning and evening. Following Marai (2001), the equation used to calculate THI is;

$$THI = t - (0.31 - \frac{0.31}{100} \times RH)(t - 14.4) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where, THI is the temperature humidity index, t is the dry bulb temperature (^{O}C) and RH is the relative humidity (%).

The temperature-humidity index (THI) values were classified as less than 26 (< 26.00), between 26 and 29 (26-29.00) and greater than 29 (> 29.00). This was used to determine the level of heat stress as; comfort limit, heat stress, and severe heat stress respectively (Duduyemi and Oseni, 2018).

Rectal emperature
A clinical thermometer was used to obtain values through cloacal insertion at a depth of 2-3cm

Wing emperature
Values for the wing temperature were determined by placing a clinical thermometer beneath the wing and recording values.

Thigh Temperature
Thigh temperatures were determined by placing the thermometer between the thigh and the rest of the body.

Weight Gain

Five Birds were sampled randomly from each replicate and weights were taken weekly. To obtain the weekly weight gain, final weight values were subtracted from values from the initial weight values.

Weight Gain = Final Weight – Initial Weight

Panting Rate

This was obtained by counting the panting breaths in a minute.

Statistical Analyses

Data were analyzed using one-way analysis of variance for a completely randomized design using (Statistical Analysis System, version 9.2, 2005) and the differences in mean values where significant were separated using the Turkey HSD Test of the same software**Experimental Diets**

Table 1: Ingredient Composition of the Experimental Diets

Ingredient	0 (%)	3 (%)	4 (%)	5 (%)
SMLM	0.00	3.00	4.00	5.00
Maize	59.00	56.00	55.00	54.00
Soyabean Meal	27.00	27.00	27.00	27.00
Palm Kernel Cake	5.00	5.00	5.00	5.00
Fish Meal	3.00	3.00	3.00	3.00
Wheat Offal	2.50	2.50	2.50	2.50
Limestone	1.50	1.50	1.50	1.50
Bone Meal	1.00	1.00	1.00	1.00
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Vitamin Premix	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**
Calculated Nutrient Values:				
Energy (Kcal/kg)	2795.54	2700.80	2669.22	2637.64
Crude Protein (%)	19.12	18.91	18.84	18.77
Crude Fibre (%)	4.56	4.47	4.44	4.41
Fat (%)	4.26	4.14	4.10	4.06

3. RESULTS AND DISCUSSION

In the course of this study relative humidity values obtained in the poultry pen ranged from 22% to 92%, while the ambient temperature values ranged from 23.3℃ to 35.8℃ with calculated THI ranging between 23.47 to 31.48.

Table 2: Physiological parameters of broiler birds fed varying levels of SMLM

Variables	T1	T2	T3	T4	SEM
Wing Temp (℃)	41.42	41.37	41.75	41.53	0.05
Thigh Temp (℃)	41.65	41.48[b]	41.83[ab]	41.00 [ab]	0.04
RectalTemp (℃)	41.70	41.57	41.76	41.72	0.04
Weight (Kg)	1.93a	1,61[b]	1.62[b]	1.73[ab]	0.04
Panting Rate	117.90	120.80	118.90	123.10	1.66

(a, b, c,) Means along the same row with different superscripts are significantly ($p<0.05$) differen.

Physiological parameters of broiler birds fed varying levels of SMLM

Mean values of physiological parameters of broiler birds fed varying levels of SMLM are recorded in Table 2. The variables monitored include wing temperature, thigh temperature, rectal temperature, and panting rate. A significant difference in thigh temperature values was revealed across treatments, with 0% and 5% SMLM supplementation showing similar values which differ from 3% and the treatment with 4% inclusion showing the highest mean value. The panting rate revealed the highest mean value in birds belonging to the 5% group, followed by birds fed with a 3% supplemented diet, then birds fed with a 4% supplemented diet, and birds in the control group contributed the lowest mean value.

THI

In the course of this study, THI values obtained indicate varied conditions which ranged from comfort limit to heat stress and severe heat stress as stated by Duduyemi and Oseni 2018.

Effect of varying levels of SMLM on Physiological parameters of broiler birds :Wing, Thigh and Rectal Temperatures

The inclusion of *Spondias mombin* leaf meal at 0%, 3%, and 5% showed a similar trend of temperature distribution. In these treatments (0%, 3%, and 5%) rectal temperature mean values are highest, followed by thigh and then wing temperatures. The treatment with 4% SMLM shows a deviation from this trend, with thigh temperature having the highest mean value and wing temperature having the lowest. All values for wing, thigh and rectal temperatures falls within the normal range for broiler birds.

Panting Rate

The mean values recorded for panting rate indicate thermal stress conditions as reported by Nascimento *et al.* (2012). This can be attributed to the high temperature-humidity index values, which is characteristic of countries located in the tropics. Higher panting mean seen in birds belonging to treatment 4 (5% SMLM) may be as a result of a combined

effect of high THI values and extra heat production through digestion and metabolism of SMLM in diet (Alaba *et al*., 2021). The *Spondias mombin* plant is rich in essential nutrients such as vitamins, minerals, and antioxidants. Including *Spondias mombin* in the diet of broilers can potentially enhance their overall nutritional intake, which is crucial for their growth and health. The antioxidants present in *Spondias mombin* fruits may contribute to strengthening the immune systems of broiler chickens (Ayoka *et al*., 2008). By boosting the immune response, broilers are better equipped to resist or combat common diseases and infections prevalent in the humid tropical zone. The presence of vitamin in leaf meal of *Spondias mombin* such as Vitamin C supplement can be most effective in suppressing thermo-physiological responses of the broiler chicken.

It also has a tangy flavour that is appealing to broilers, increasing their feed intake. Improved palatability can enhance feed consumption, leading to better growth rates and feed conversion efficiency (Ijadunola *et al*., 2020). Immune system of broiler chickens (Ayoka *et al.,* 2008). By boosting the immune response, broilers are better equipped to resist or combat common diseases and infections prevalent in the humid tropical zone. The presence of vitamin in leaf meal of *Spondias mombin* such as Vitamin C supplement can be most effective in suppressing thermo-physiological responses of the broiler chicken. It also has a tangy flavour that is appealing to broilers, increasing their feed intake. Improved palatability can enhance feed consumption, leading to better growth rates and feed conversion efficiency (Ijadunola *et al*., 2020).

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4. CONCLUSION

From the results of this study, the inclusion of *Spondias mombin* leaf meal (SMLM) showed no adverse effect on the physiology of the birds. SMLM inclusion can be reported to be safe at 3%, 4% and 5% dietary inclusion levels. Comparable weight gains of birds fed diets containing 5% SMLM similar to those on the control diet, indicate potential as a partial substitute for maize in the broiler industry.

5. RECOMMENDATION

With the promising potential of *Spondias mombin* in broiler feeding, further study should be carried out to determine its effect on broiler thermoregulation at higher levels of inclusion. Its commercial production should also be encouraged to ensure availability and reduce dependence on maize in broiler diets.

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