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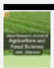

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Effects of different roofing materials on the growth performance, haematological profile and welfare of broiler chickens

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ABSTRACT

This study investigated the effects of different roofing materials on the growth performance, haematological profile and welfare of broiler chickens. Thirty-six (36) 4-week-old Arbor Acre broiler chickens were randomly allocated to three treatment groups: houses covered with corrugated iron roofs (CIR), (houses covered with asbestos cement roofs (ACR), and (houses covered with tarpaulin roofs (TPR), with 12 birds per treatment replicated thrice at four birds per replicate. The birds were reared for 28 days under controlled conditions, and data on ambient temperature, feed intake, body weight, weight gain, feed conversion ratio (FCR) and haematological parameters were collected. Results revealed significant differences ($p < 0.05$) in the ambient temperatures across treatments. The CIR group recorded the highest average temperature (33.13°C), followed by TPR (28.89°C) and ACR (27.11°C). Growth performance metrics, including feed intake, weight gain and FCR, were significantly lower in the CIR group compared to the ACR and TPR groups, which exhibited statistically similar performance. Haematological analysis showed higher levels of heterophil, basophil and heterophil-to-lymphocyte (H/L) ratios in the CIR group, indicating increased heat stress levels. In contrast, ACR and TPR groups exhibited higher levels of lymphocyte, monocyte, haemoglobin and haematocrit. Due to their high thermal conductivity, corrugated iron roofs resulted in heat stress, reduced growth and impaired haematological parameters. Conversely, asbestos cement and tarpaulin roofs provided better thermal insulation, enhancing growth performance and welfare. It was concluded that roofing materials influence the growth performance, haematological parameters and welfare of broiler chickens.

***Keywords**: Broiler, Poultry Welfare, Thermal Comfort, Heat Stress*

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INTRODUCTION

The rapidly increasing demand for poultry products, such as eggs and meat, calls for optimizing the performances of poultry birds. While several factors influence the productivity of poultry birds, housing conditions, particularly the ambient temperature, play a vital role in poultry performance, thermal comfort and welfare. As homeothermic, birds can regulate their internal body temperature. However, this thermoregulatory function is most effective within a thermoneutral zone, usually 21-28ºC (70–82°F) for broiler chickens (Soliman and Safwat, 2020). Hence, when the environmental or ambient temperatures exceed this thermoneutral zone, they become heat-stressed (Purswell *et al.*, 2012). One of the major elements that influence the internal temperature of poultry houses is the roofing material used. Roofing materials have varying thermal properties that impact how heat is absorbed and dissipated within the house or pen. Studies, such as those by Lapisa *et al*. (2020) and Das *et al*. (2023), have demonstrated that roofing materials with high thermal conductivity result in high ambient temperatures compared to insulating roofing materials. Nevertheless, limited empirical studies have examined how different roofing materials impact broiler chickens' production performance, physiological functions and welfare.

Addressing this knowledge gap is critical, especially in tropical and subtropical regions, where high ambient temperatures significantly challenge poultry production. Optimizing the choice of roofing materials in these regions could improve thermal comfort, enhance productivity and reduce economic losses associated with heat stress. This study aims to investigate the effects of three common roofing materials (corrugated iron, asbestos-cement and tarpaulin) on ambient temperature, growth performance, haematological profile and welfare of broiler chickens.

MATERIALS AND METHODS

The experiment was conducted at the Poultry Unit of the Teaching and Research Farm of the Federal University of Technology, Akure, Nigeria. It was carried out during the hot season (February and March) when the temperature typically ranges between 29°C and 40°C. A total of thirty-six (36) 4-week-old Arbor Acrwith similar body weights were randomly selected and allotted to three treatments, which were CIR (houses covered with corrugated iron roofs), ACR (houses covered with asbestos cement roofs) and TPR (houses covered with tarpaulin roofs). The treatments were replicated thrice with four birds per replicate. The orthographic and isometric views and dimensions of the experimental house are shown in (Figures 1 and 2), respectively. The broiler chickens were provided with feed and water ad libitum for 28 days.

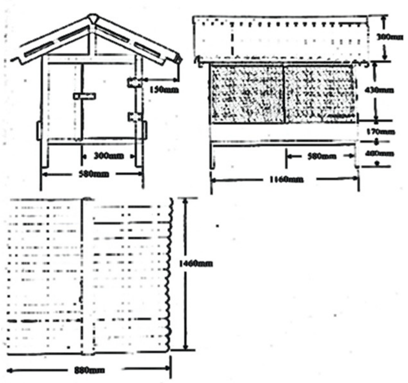

Figure 1: The dimensions and orthographic view of the house

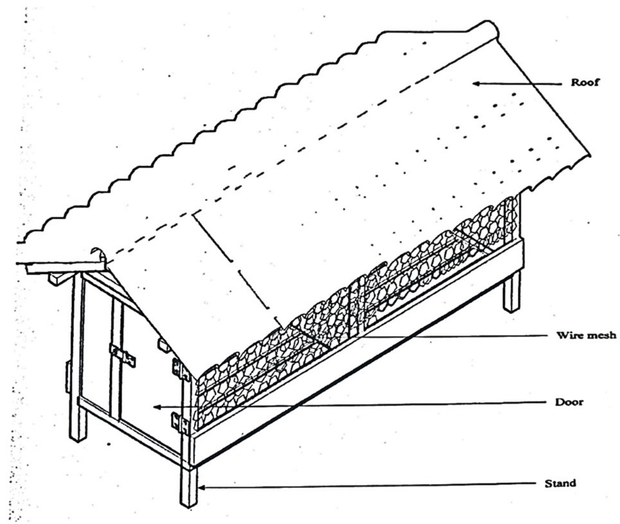

Figure 2. The isometric view of the house

Procurement and processing of experimental diet

The feed ingredients used in producing the experimental diet were purchased from K2 Feedmill Akure, Ondo State. The diet was prepared at the Nutrition Laboratory of the Department of Animal Production and Health, Federal University of Technology, Akure. The feed was produced using the feed formula in (Table 1).

Table 1: Composition of the experimental diet.

Ingredient	Quantity (%)
Maize	62.5
Soybean meal	18.55
Groundnut cake	7
Brewer's dried grain	5
Vegetable oil	3.5
Bone meal	2
Oyster shell	0.5
Premix	0.25
Methionine	0.1
Lysine	0.1
Salt	0.5
Total	100
Calculated Analysis	
Metabolizable energy	3200 Kcal/kg
Crude protein	20.00%

Data collection and analysis

The initial weights of the experimental birds were taken and recorded before they were fed on the morning of day 1. The ambient temperature in each house was measured using a digital thermometer at 14:00 each day. Other data collected were daily feed intake (FI), body weight (BW) and weight gain (WG). On the 29th day, all the birds were weighed to get their final body weights

(FBW). The average ambient temperature was calculated using the following formulas.

Average ambient temperature (ºC)

$$AAT\ (^{o}C) = \frac{\text{Sum of temperature per treatment from day 1 to 28}}{28}$$

On the morning of day 29, blood samples were collected through the wing veins of six birds in each treatment group (2 birds per replicate) at 2 ml per bird into an ethylenediaminetetraacetic acid (EDTA) tube to prevent coagulation. The haematological parameters analysed in the laboratory include lymphocyte, heterophil, basophil, eosinophil, monocyte, H/L ratio, haemoglobin and haematocrit following standard laboratory procedures.
Data collected were subjected to one-way analysis of variance (ANOVA) using the SPSS version 17 package. Means differences were evaluated using Duncan's multiple range test at a significance level of $p < 0.05$.

RESULTS AND DISCUSSION

Average ambient temperature

Table 2 shows the average ambient temperature for the whole duration of the experiment. A significant difference ($p < 0.05$) was observed in the average ambient temperature across all treatments. The ambient temperature was significantly higher in treatment CIR compared to treatments ACR and TPR.

Table 2: Average ambient temperature.

Treatment	Ambient Temperature (ºC)
CIR	33.13[c]
ACR	27.11[a]
TPR	28.39[a]
SEM	0.12

[ab] Means within a column differ significantly ($p < 0.05$); CIR = corrugated iron roof; ACR = asbestos-cement roof; TPR= tarpaulin roof; SEM = Standard error of the mean

Average ambient (air) temperatures observed for Treatments CIR, ACR, and TPR were 33.13ºC, 27.11ºC and 28.89ºC, respectively. According to Lapisa *et al.* (2020), the type of roofing materials significantly impacts indoor temperature profiles and thermal comfort levels. This was confirmed in the current study as the corrugated iron, asbestos-cement and tarpaulin roofs significantly influenced ($p < 0.05$) the ambient temperatures in the prototype pens. A similar result was observed in the study of Das *et al.* (2023), in which unpainted corrugated iron roofs recorded higher temperatures than those coated with red rust-proof paint. The significant variations in ambient temperatures observed in the present study may be attributed to differences in the thermal properties of the roofing materials. A corrugated iron sheet, being a metal, is a good conductor of heat (Yang and Liu, 2007). Conversely, the asbestos-cement and tarpaulin are insulators with very low thermal conductivities (Onyeaju *et al.*, 2013).

Feed intake and growth performance

A significant difference ($p < 0.05$) was observed in the FI, FBW, WG, and FCR. The FI of the birds in the CIR group was significantly lower ($p < 0.05$) compared to the ACR and TPR groups. Similarly, the lowest FBW and WG were observed in the CIR group compared to the CIR and TPR groups (Table 3). Birds in the CIR group exhibited a higher FCR than those in the CIR and TPR groups. These results could be attributed to the physiological effects of heat stress on the birds. Poultry birds reduce feed consumption as a physiological response to elevated environmental temperatures to minimize metabolic heat production. This supports the reduced FI observed in the corrugated iron roof (CIR) group, where the birds were exposed to the higher ambient temperatures (Table 3). Chickens can maintain a relatively stable internal body temperature but can optimally regulate it only when housed within their thermoneutral zone, typically between 21 and 28°C (Soliman and Safwat, 2020). However, exposure to environmental temperatures exceeding the upper limit of this range can cause heat stress (Purswell *et al.*, 2012), negatively impacting the chickens' overall performance. Heat stress also impairs nutrient absorption, metabolic efficiency and growth rates (Wasti *et al.*, 2020; Nawaz *et al.*, 2021), explaining the lower weight gain and poorer FCR observed in the CIR group. In contrast, the cooler conditions under ACR and TPR roofs likely mitigated these effects, resulting in better growth performance and feed conversion efficiency (Table 3).

Haematological parameters

The roofing materials had significant effects ($p < 0.05$) on the levels of lymphocyte, heterophil, basophil, monocyte, H/L ratio, haemoglobin and haematocrit of the broiler chickens, except for eosinophil (Table 4). Birds in the ACR and TPR treatment groups exhibited higher ($p < 0.05$) lymphocyte, monocyte, haemoglobin and haematocrit levels. However, birds in the CIR showed significantly higher ($p < 0.05$) heterophil, basophil and H/L ratio compared to those in the ACR and TPR groups. These results agree with Altan *et al.* (2000) and Jaiswal *et al.* (2017), who observed decreased lymphocytes, monocytes, haematocrits and haemoglobins as well as increased heterophils, basophils and H/L ratio in broiler chickens that were severely stressed. This also confirms that high ambient heat is an environmental stressor for chickens. Heat stress adversely affects chickens'

Table 3. Growth performance of the experimental birds.

Parameters	CIR	ACR	TPR	SEM
Initial weight (g/bird)	830.08	823.42	832.92	2.51
Final weight (g/bird)	2367.83[b]	2670.17[a]	2643.83[a]	24.29
Weight Gain (g/bird)	1537.75[b]	1846.75[a]	1810.91[a]	25.25
Feed intake (g/bird)	3373.50[b]	3821.67[a]	3815.50[a]	38.85
Feed conversion ratio	2.19[a]	2.07[b]	2.11[b]	0.02

[ab] Means within a row differ significantly ($p < 0.05$); CIR = corrugated iron roof; ACR = asbestos-cement roof; TPR= tarpaulin roof; SEM = Standard error of the mean

Table 4: Haematological parameters of experimental broiler chickens.

Parameters	CIR	ACR	TPR	SEM
Lymphocyte (%)	53.94[b]	64.08[a]	62.52[a]	0.83
Heterophil (%)	31.31[a]	21.67[b]	22.03[b]	0.61
Basophil (%)	2.83[a]	2.17[c]	2.40[b]	0.18
Eosinophil (%)	1.67	1.50	1.51	0.17
Monocyte (%)	6.17[b]	8.11[a]	8.04[a]	0.73
H/L ratio	0.58[a]	0.34[b]	0.35[b]	0.79
Haemoglobin (g/100ml)	8.15[b]	10.34[a]	10.03[a]	0.13
Haematocrit (%)	27.04[b]	30.50[a]	30.83[a]	0.82

[abc] Means within a row differ significantly ($p < 0.05$); CIR = corrugated iron roof; ACR = asbestos-cement roof; TPR= tarpaulin roof; SEM = Standard error of the mean

haematological components and immune function.

Conclusion

Based on the findings of this study, it can be concluded that roofing materials significantly influence the growth performance, haematological profile and welfare of broiler chickens. Corrugated iron roofs are less suitable for poultry housing in hot climates as they are linked with higher ambient temperatures, poor growth performance and increased physiological stress. On the other hand, asbestos-cement and tarpaulin roofs provide better thermal insulation, creating an environment more conducive to broiler productivity and welfare.

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