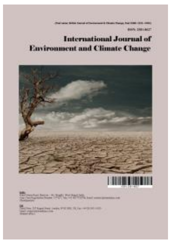

International Journal of Environment and Climate Change

Volume 13, Issue 8, Page 127-140, 2023; Article no.IJECC.99382
ISSN: 2581-8627
(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)

Effects of Colored Polymer Light and Feed Forms on the Performance of Broiler Chickens in the Humid Tropical Climate

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Authors' contributions

This work was carried out in collaboration among all authors. Authors MA and AOJ designed the study. All authors managed the activities of the experiment and interpreted the data collectively. Authors MA, AOJ, ROA, OAA and ANF prepared the proposal for the study. Authors ROA and OAA prepared the first draft of the manuscript. Author AOJ reviewed the first draft and author MA reviewed the second draft. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJECC/2023/v13i81939

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/99382

Original Research Article

Received: 08/03/2023
Accepted: 10/05/2023
Published: 22/05/2023

ABSTRACT

Aims: The colours of the polymer used during brooding could impair the vision of the chicks. For chicks reared in the dark environment, they have limited access to daylight and find it difficult to gain access to feed and water. Therefore, for better understanding of the effect of the polymer colours on broiler production in the humid tropical climate, a study was carried out to evaluate the effect of coloured polymer light filter and feed forms on performance of broiler chickens.

Methodology: A total of two hundred and forty (240) chicks were allocated in 2 × 4 factorial arrangements with two feed forms (mash and pellet). The chicks were reared under four (4)

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different coloured polymer light filter, namely; white (T_1), blue (T_2), black (T_3), and green (T_4) and an incandescent bulb (100 Watts) each.

Results: The results showed that the birds reared under the white polymer light filter had the highest weight gain (1565.28 g), while the least weight gain (1469.72 g) was observed in birds reared under black polymer light filter. For rectal temperature of the birds, it was discovered that broiler chicken reared under white polymer light filter had the highest rectal temperature (39.63°C), while the least rectal temperature of 39.33°C was observed in the chicken reared under black polymer light filter. The highest environmental temperature (34.03°C) was observed in birds reared under black polymer light filter, while the least environmental temperature (30.03°C) was observed in birds reared under white polymer light filter. The results further showed that birds fed with pelletized feed form had the highest weight gain than the birds fed with mashed feed form.

Conclusions: From the findings of this study, it is certain that polymer light filter and feed forms are important factors that could influence birds' performance.

Keywords: Carcass; environmental temperature; internal organ; rectal temperature; weight gain.

1. INTRODUCTION

Broiler chickens (*Gallus gallus domesticus*) are domesticated fowl, bred and raised specifically for meat production. Over the years, the poultry sector has been crucial in supplying the need for animal protein that has been in short supply [1]. The significance of animal protein remains undisputed whereby animal protein gives humans high-quality nutrition that promotes growth, development, and tissue replacement [2].

Raising broiler chickens above the thermoneutral zones could make the bird susceptible to heat stress [9]. The body temperature of broiler chicken is between 39 - 42°C. Broiler starter chicks require environmental temperature of 29 - 32°C, while environmental temperature of 23 - 28°C is needed at the finished phase of the birds [10]. Stanishevshevskaya OL and Fedorava E.S [11] reported that a day-old chicks have difficulty in maintaining their body heat because their thermoregulatory capacity is not well developed. Heat stress has detrimental impacts on physiological function and growth performance, manifesting as lower feed consumption, reduced body weight gain, and lower feed efficiency [12]. Thus this study was designed to evaluate the effects of sidewall covering colours on the performance of broiler chickens raised in the humid tropical climate.

According to [3], the term "nylon" refers to a family of synthetic polymers made up of polyamides (repeating units connected by amide linkages). Fabric and fibers made of nylon polymers have several commercial uses. Poultry are very sensitive to polymer light filter during the brooding phase. Light not only allows them to be active and find food, but it also stimulates their brains for seasonal reproduction [4]. It has been shown that the first two weeks of broiler's life are the most crucial because any management errors will significantly affect how they turn out [5]. According to [6], broilers raised under blue or green light polymer had high weight gain but feed conversion and mortality remained constant.

Although it is generally accepted that pellet diets promote broiler growth, several studies have found no difference between the performance of chickens fed pellet or mash diets [7], feed forms are one of the most crucial elements affecting how well broiler chicken utilize their feed. Mash diets gives greater unification of growth, less death loss and are more cost-effective because pellets costs slightly more than the same ration in mash form [8].

2. MATERIALS AND METHODS

2.1 Experimental Site

The study was carried out at the Poultry Unit of the Teaching and Research Farm, Federal University of Technology, Akure, Nigeria located on Latitude 7°18'N and Longitude 5° 10'E [13,14]. The study area is located in the humid rain forest zone of Western Nigeria with tropical climate of two seasons: rainy season (April - October) and dry season (November - March) with a mean annual rainfall of 2400 mm, an average annual temperature of 26.7°C and an average relative humidity of 86 % [14].

2.2 Housing System of the Experimental Birds

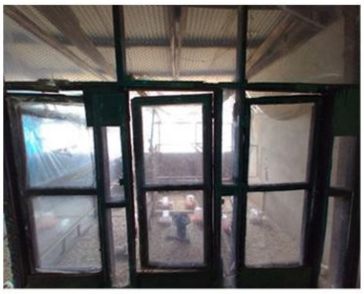
An open-sided poultry house was used due to the high temperature 26.7°C in the research area. Open-sided poultry house allows air to flow in and out of the house. The side walls are about 2.6 m high; the upper part of the wall is covered with wire mesh to prevent rodent and wild birds from entering the poultry house. The open sidewalls were completely covered with polymer of different colours (white, blue, black and green) during the brooding stage. The house was divided into sixteen (16) pens, with each polymer color having four (4) pens. The concrete floor was completely covered with litters (wood shaving) of about 0.03 m thickness. Adequate floor space (13.23 m width) was provided in each treatment to avoid overcrowding, the floor space was 1.4 m x 1 m.

2.3 Polymer Light Filter Materials

Four (4) polymers with different colours (white, blue, black and green) were sourced from local vendor in Akure, Nigeria. The polymers which serve as the treatments were used for brooding the chicks between two (2) – three (3) weeks. Each polymer was used to cover the pen during brooding to produce different vision to the chicks, as presented in Plate 1a, b, c and d. The polymer sheets were raised up at the beginning of the third week of keeping the chicks as presented in Plate 1a to d. White polymer represents treatment I (control), blue polymer represents treatment II, black polymer represents treatment III and green polymer represents treatment IV.

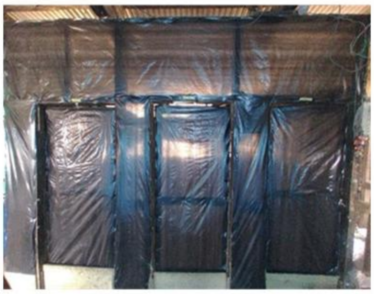
2.4 Experimental Diets

All the broiler chicks between 0 – 3weeks were fed with commercial starter feed with same nutrient composition but different feed forms (mash and crumble) and these were purchased from a reputable feed mill industry. The starter diet contained 22% crude protein and 3000kcal/kg metabolizable energy. At the beginning of the fourth week, the starter diet was changed to finisher diet. The finisher diet contained 19% crude protein and 3200kcal/kg metabolizable energy..

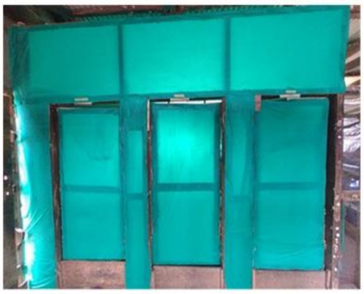


(a) White polymer light filter

(b) Blue polymer light filter



(c) Black polymer light filter



(d) Green polymer light filter

Plate 1. Polymer used to cover the pen during brooding to produce different vision to the chicks

2.5 Thermal Comfort Assessment

The thermal condition within each treatment was properly assessed using an internet of things (IoT) based sensors. The sensors were placed in the pen at 1.0 m above the floor to prevent the birds from interacting and destroying the sensors. The environmental temperatures at the microclimate of the birds were measured using temperature (DHT11) sensors. The data from the sensors was processed, monitored and stored on the internet using a Wi-Fi module ESP8266. The data was constantly monitored on the mobile phone through a platform called Thing View, readily available on google play store for Android phones, to prevent error and also to ensure that the data was adequately acquired and stored. The data was later downloaded on a laptop (HP ProBook 4540s) for further processing. To understand the effect of the coloured polymer on the climatic condition, feed consumption, and heat stress level, the air temperature measurements were determined at an interval of 30 seconds over the period of the study

2.6 Cloacal Temperature Measurement

The body temperatures of marked birds were measured with a non-contact infrared thermometer model:HT-668. The infrared thermometer has an accuracy of 0.1 ºC and 0.5 seconds response time. The temperature was taken at the cloaca region when the environmental temperature is at its peak (34°C) i.e., between 12:00 noon - 12:30 pm. This was done to understand the relationship between the body temperature and the environmental temperature in the bird's environment/different unit and also to understand the relationship between the feed and water intake.

2.7 Growth Performance Evaluation

At the beginning of the experiment the initial weights of the chicks were measured using sensitive weighing scale Model: EK5055 (5 kg mini digital scale) and the values were documented for each replicate. The measurement was repeated on weekly basis for six (6) weeks that the experiment lasted. The chicks were marked with animal marker and were randomly selected and weighed. The weights of the birds were taken individually and also in groups. At three (3) weeks of the study, 40 kg sensitive weighing scale was used to weigh the birds. Weight change (g) was determined at the end of the experiment by deducting the initial weight (g) from the final weight (Equation 1).

$$\text{Weight change (g)} = \text{final weight (g)} - \text{initial weight (g)} \quad (1)$$

Feed intake (g) was determined daily by weighing the feed offered using sensitive scale to chicken in each pen throughout the experimental period. The difference in the total feed offered (g) and weigh back was documented as the feed intake (Equation 2).

$$\text{Feed intake (g)} = \text{total feed offered (g)} - \text{weigh back (g)} \quad (2)$$

Water intake (ml) was also determined by measuring the water given to the birds daily throughout the experimental period using calibrated cylinder (1000ml capacity). The difference in the total water administered (ml) and weight back (ml) was recorded as the water intake (Equation 3).

$$\text{Water intake (ml)} = \text{total water offered (ml)} - \text{weigh back(ml)} \quad (3)$$

Feed conversion ratio (FCR) was calculated using Equation 4 by dividing the total feed consumed (kg) by weight gain (kg) using Microsoft excel.

$$\text{FCR} = \frac{\text{total feed consumed(kg)}}{\text{weight gain (kg)}} \quad (4)$$

2.8 Carcass and Relative Organ Measurements

At the end of the experiment (42 days), twenty-four (24) birds per treatment (polymer color) were carefully loaded into a mini transportation truck of 200 capacities and transported to the slaughter house as early as 6:00am to avoid stress. The birds were allowed to rest for about 30 minutes to 1 hour before being processed for carcass and relative internal organ evaluation.

The carcass was dressed and eviscerated according to the procedure of [15]. The dressed weight (%) was calculated using Equation 5 after defeathering, slitting the shank and head. The dressed weight (g) was expressed as the percentage of pre-slaughter weight (g).

$$\text{Dressed weight (\%)} = \frac{\text{dressed weight}}{\text{live weight}} \times 100 \quad (5)$$

A median cut was done in the abdomen to remove viscera, heart, liver, pancreas, spleen, and gizzard were weighed separately. The giblets (heart, liver, and gizzard) were cleaned and retained along with the carcass. The eviscerated weight in Equation 6 was recorded and expressed as a percentage of pre-slaughter weight.

$$\text{Eviscerated weight (\%)} = \frac{\text{eviscerated weight (g)}}{\text{live weight (g)}} \times 100 \quad (6)$$

A slit was made around each drumstick to expose the tendons. Likewise, the thigh, wing, back, breast of the eviscerated birds was cut.

The measurements (weight) of the relative organs such as the heart, spleen, liver and lungs, gizzard, proventriculus were determined and documented. The organs were weighed and expressed as g/kg of the live weight of the birds. The length of the intestinal organs was measured using measuring tape. The carcass processing was done in hygienic environment.

2.9 Experimental Design / Statistical Analysis

For this trial, a 2x4 factorial arrangement design was adopted. This shows that there were two (2) levels of feed forms (mash and pellet) and four (4) levels of colored polymer (white, black, blue and green) of six (6) replicates and ten (10) chicks per replicate. All the data generated such as growth performance, water intake, organs and carcass characteristics, individual bird's body temperature and environmental temperature were processed and subjected to analysis of variance (ANOVA) using Microsoft Excel 2019 and SPSS version 25 package respectively, where differences occurred, Duncan Multiple Range Test (DMRT) was engaged to compare the differences among the means. Differences were considered to be statistically significant if probability value (*p*-value) was less than 0.05 The statistical model is shown in equation 7.

$$Y_{ijk} = \mu + A_i + B_j + (AB)_{ij} + \mathcal{E}_{ijk} \quad (7)$$

Where: Y_{ijk} is individual observation, μ is general mean, $A_i$is effect of treatment, $B_j$is effect of feed form, $(AB)_{ij}$ is effect of interaction treatment and feed form and $\mathcal{E}_{ijk}$ = experimental error.

3. RESULTS

3.1 Growth Performance of Experimental Birds at Age (1-42 Days)

Table 1 shows the performance of broiler chickens reared under coloured polymer light filter and feed forms at age. All the parameters measured were not significantly (p>0.05) influenced by different polymer colour light filter. Birds reared under the white polymer light filter had the best final weight (1605.75 g), weight gain (1565.28 g), feed intake (3050.53 g), and water intake (7865.00 ml), while least final weight (1510.53 g) and weight gain (1469.72 g) were observed in birds reared under black polymer light filter, least feed intake (2947.06 g) was observed in birds reared under the blue polymer light filter, and least water intake (7524.86 ml) was observed in birds reared under green polymer light filter. The best feed conversion ratio (1.96) was observed in birds reared under the white polymer light filter, while the least feed conversion ratio (2.06) was observed in birds reared under the black polymer light filter.

The environmental and rectal temperatures measured were significantly (p<0.05) influenced by the polymer colors. The highest environmental temperature (34.03°C) was observed in birds reared under black polymer light filter, while the least environmental temperature (30.03°C) was observed in birds reared under white polymer light filter. The highest rectal temperature (39.63°C) was observed in chicks reared under white polymer light filter, while the least rectal temperature (39.33°C) was observed in chicks reared under black polymer light filter.

All the parameters measured were not significantly (p>0.05) influenced by the feed forms. Numerically, highest final weight (1901.49 g), weight gain (1860.83 g), feed intake (3531.23 g), water intake (9004.92 ml), and best feed conversion ratio (1.89) were obtained in birds fed pelletized feed while, least final weight (1192.03 g), weight gain (1151.79 g), feed intake (2457.91 g), water intake (6355.28 ml), and worst feed conversion ratio (2.15) were recorded in birds fed mash feed.

The rectal and environmental temperatures were not significantly (p>0.05) influenced by the feed forms, highest rectal temperature (39.63°C) was observed in birds fed pelletized feed and least rectal temperature (39.33°C) was observed in birds fed mash feed while highest environmental temperature (33.32°C) was observed in birds fed mash feed while the least environmental temperature was observed in birds fed pelletized feed.

The all the parameters measured were not significantly (p>0.05) influenced by the interaction between the polymer light filter and feed forms. Although, highest final weight (1967.78 g), weight gain (1926.83 g), feed intake (3647.83 g) and water intake (9570.00 ml) were observed in birds reared under blue polymer light filter and fed pelletized feed. The least final weight (1081.22 g), weight gain (1040.56 g), feed intake (2246.28 g) was observed in birds reared under blue polymer and fed mash feed and lowest water intake (5979.72 ml) was observed in birds reared under black polymer and fed mash feed. The best feed conversion ratio (1.88) was obtained in chicks reared under the blue polymer light filter and fed pelletized feed, while the least feed conversion ratio (2.23) was observed in birds reared under the black polymer light filter and fed mash feed.

The rectal and environmental temperatures were not significantly (p>0.05) influenced by the interaction between the polymer light filter and feed forms. Numerically, highest rectal temperature (39.82°C) and the least rectal temperature (39.16°C) were observed in chicks reared under blue polymer light filter and fed pelletized feed and chicks reared under black polymer light filter and fed mash feed respectively. The highest environmental temperature (34.33°C) was observed in birds reared under blue polymer and fed pellet feed while the lowest highest environmental temperature (28.39°C) was observed in birds reared under white polymer light filter and fed pelletized feed.

3.2 Carcass Measurement

The carcass measurement of birds reared under differently colored polymer light filter with different feed forms are presented in Table 2. All the parameters measured were not significantly (p>0.05) influenced by the polymer light filter. Experimental birds reared under white polymer had the highest live weight (1648.33 g), dressed weight (91.35 %) and eviscerated weight (75.39 %), while least live weight (1528.67 g), dressed weight (90.97 %) and eviscerated weight (73.56 %) were observed in birds reared under the black polymer light filter.

The result of the feed forms revealed that, all the parameters measured were not significantly (p>0.05) influenced by the feed forms. Numerically, the highest live weight (1943.00 g), dressed weight (91.68 %) and eviscerated weight (76.70 %) were obtained in birds fed pelletized feed, while least live weight (1217.67 g), dressed weight (90.56 %) and eviscerated weight (71.93 %) were obtained in birds fed mash feed.

The interaction between the polymer light filter and feed forms was determined, all the parameters measured were not significantly (p>0.05) influenced by the interaction between the polymer light filter and feed forms. Although, highest live weight (1977.33 g) was obtained in birds reared under blue polymer light filter and fed pelletized feed and the lowest live weight (1096.33 g) was observed in birds reared under the blue polymer light filter and fed mash feed. The highest dressed weight (92.77 %) and eviscerated weight (78.51 %) were obtained in birds reared under white polymer light filter and fed pellet, and least dressed weight (89.90 %) and least eviscerated weight (71.33 %) were observed in birds reared under white polymer light filter and fed mash feed and birds reared under black polymer light filter and fed mash feed respectively.

3.3 Organ Characteristics

The organ characteristics of birds reared under differently colored polymer light filter with different feed forms are presented in Table 3. Only the gizzard weight, proventriculus weight and intestinal length were significantly (p<0.05) influenced by the polymer light filter. The highest liver weight (21.32 g/kg) and the least liver weight (19.39 g/kg) were observed in birds reared under black polymer light filter and birds reared under green polymer light filter respectively. Numerically, the highest gizzard weight (20.41 g/kg) and belly fat weight (4.12 g/kg) were observed in birds reared under white polymer light filter and least gizzard (18.79 g/kg) and belly fat weight (1.74 g/kg) were observed in birds reared under blue polymer light filter. The highest heart weight (4.06 g/kg) and intestinal length (241.25 cm) were observed in birds reared under white polymer and the lowest heart weight (3.59 g/kg) and intestinal length (212.58 cm) were observed in birds reared under green polymer light filter.

Table 1. Performance of broiler chickens reared under differently colored polymer light filter and feed forms (1-42 days)

		Initial Weight (g)	Final Weight (g)	Weight Gain(g)	Feed Intake(g)	Feed Conversion Ratio	Water Intake(ml)	Environmental Temperature (°C)	Rectal Temperature (°C)
Color	White	40.47	1605.75	1565.28	3050.53	1.96	7865.00	30.03^{c}	39.63^{a}
	Blue	40.81	1524.50	1483.69	2947.06	2.03	7802.22	33.95^{a}	39.57^{a}
	Black	40.81	1510.53	1469.72	2962.18	2.06	7528.31	34.03^{a}	39.33^{b}
	Green	39.69	1546.26	1506.56	3018.52	2.02	7524.86	33.65^{b}	39.40^{b}
	SEM	±0.42	±44.00	±43.91	±75.81	±0.03	±227.81	±0.09	±0.03
	p-value	0.24	0.46	0.45	0.75	0.24	0.61	0.00	0.00
Feed form	Mash	40.24	1192.03	1151.79	2457.91	2.15	6355.28	33.32	39.33
	Pellet	40.65	1901.49	1860.83	3531.23	1.89	9004.92	32.51	39.63
	SEM	±0.29	±31.11	±31.05	±53.60	±0.02	±161.08	±0.06	±0.02
	p-value	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Color*feed Mash	White	40.67	1331.89	1291.22	2644.22	2.05	6958.89	31.65	39.56
	Blue	40.67	1081.22	1040.56	2246.28	2.17	6034.44	33.54	39.33
	Black	41.11	1117.83	1076.72	2389.61	2.23	5979.72	34.05	39.16
	Green	38.50	1237.18	1198.68	2551.53	2.13	6448.06	33.98	39.29
Pellet	White	40.28	1879.61	1839.33	3456.83	1.88	8771.11	28.39	39.69
	Blue	40.94	1967.78	1926.83	3647.83	1.89	9570.00	34.33	39.82
	Black	40.50	1903.22	1862.72	3534.74	1.89	9076.89	34.01	39.50
	Green	40.89	1855.33	1814.44	3485.50	1.92	8601.67	33.33	39.52
	SEM	±0.59	±62.23	±62.09	±107.21	±0.05	±322.16	±0.13	±0.04
	p-value	0.09	0.06	0.06	0.07	0.34	0.06	0.00	0.00

Mean±SEM= Standard Error of Means; $^{a-c}$Means within a column with different superscripts are significantly different ($p<0.05$)

Table 2. Effect of polymer color and feed forms on carcass characteristics of broiler chicken

		Live Weight (g)	Dressed Weight (%)	Eviscerated Weight (%)	Thigh (g/Kg/body weight)	Drum Stick (g/Kg body weight)	Wing (g/Kg body weight)	Back (g/Kg body weight)	Head (g/Kg body weight)	Chest (g/Kg body weight)	Shank (g/Kg body weight)	Neck (g/Kg body weight)
Color	White	1648.33	91.35	75.39	104.71	96.24	73.61	130.77	26.09[b]	233.43	38.67	33.91
	Blue	1536.83	90.98	74.24	98.77	92.63	78.56	134.79	28.98[a]	217.74	41.31	32.58
	Black	1528.67	90.97	73.56	99.48	94.09	81.09	133.65	26.87[ab]	230.21	41.82	31.47
	Green	1607.50	91.19	74.06	105.53	91.47	76.19	131.13	26.85[ab]	223.22	39.49	34.52
	SEM	±42.00	±0.53	±0.68	±4.49	±3.66	±2.49	±5.91	±0.72	±13.17	±1.32	±1.34
	p-value	0.15	0.95	0.28	0.61	0.81	0.19	0.95	0.04	0.83	0.30	0.38
Feed form	Mash	1217.67	90.56	71.93	99.93	95.11	82.41	132.94	31.74	206.42	44.13	34.19
	pellet	1943.00	91.68	76.70	104.31	92.11	72.32	132.23	22.66	245.88	36.52	32.05
	SEM	±29.70	±0.38	±0.48	±3.17	±2.59	±1.76	±4.18	±0.51	±9.31	±0.94	±0.95
	p-value	0.00	0.04	0.00	0.33	0.42	0.00	0.91	0.00	0.00	0.00	0.11
Color*feed	white	1323.00	89.90	72.28	98.31	94.29	75.73	126.5	30.05	203.47	41.82	35.05
Mash	Blue	1096.33	90.94	72.02	92.68	91.79	82.37	135.06	34.26	191.85	44.99	32.23
	Black	1123.33	90.36	71.33	103.70	100.66	92.09	145.36	31.81	231.57	46.97	34.57
	Green	1328.00	91.04	72.07	105.04	93.69	79.44	124.80	30.82	198.78	42.76	34.91
Pellet	white	1973.67	92.77	78.51	111.11	98.19	71.49	135.03	22.13	263.38	35.53	32.77
	Blue	1977.33	91.02	76.45	104.86	93.47	74.75	134.52	23.69	243.67	37.63	32.93
	Black	1934.00	91.59	75.79	95.26	87.53	70.09	121.91	21.93	228.85	36.67	28.37
	Green	1887.00	91.36	76.05	106.02	89.25	72.93	137.47	22.88	247.65	36.23	34.12
	SEM	±59.40	±0.76	±0.96	±6.35	±5.18	±3.52	±8.36	±1.01	±18.62	±1.87	±1.89
	p-value	0.04	0.26	0.66	0.29	0.37	0.06	0.15	0.45	0.33	0.69	0.31

Mean±SEM= Standard Error of Means; [ab] Means within a column having different superscripts are significantly different (p<0.05)

Table 3. Effect of polymer color and feed forms on organ characteristics (g/Kg body weight) of broiler chicken

		Liver	Heart	Spleen	Gizzard	Belly Fat	Pancreas	Lungs	Proventriculus	Intestinal Length (cm)
Color	White	19.91	3.59	0.76[b]	20.41[a]	4.21	2.45[ab]	5.48	5.05[ab]	212.58[b]
	Blue	21.29	4.05	1.05[a]	18.79[b]	1.74	2.69[a]	5.62	4.43[c]	214.83[b]
	Black	21.32	4.02	1.07[a]	19.86[ab]	2.25	1.74[b]	5.95	5.08[ab]	215.42[b]
	Green	19.39	4.06	0.93[ab]	19.63[ab]	2.91	2.80[a]	5.84	5.29[a]	241.25[a]
	SEM	±1.27	±0.29	±0.09	±0.49	±1.16	±0.25	±0.44	±0.24	±7.80
	p-value	0.62	0.63	0.08	0.16	0.48	0.02	0.88	0.08	0.04
Feed form	Mash	22.21	4.13	1.02	22.85	2.07	2.63	5.71	5.49	208.92
	Pellet	18.75	3.73	0.88	16.49	3.49	2.22	5.73	4.43	233.13
	SEM	±0.89	±0.21	±0.06	±0.35	±0.82	±0.18	±0.31	±0.17	±5.52
	p-value	0.01	0.18	0.14	0.00	0.23	0.11	0.96	0.00	0.00
Color*feed	White	21.39	3.65	0.77	23.97	3.97	2.89	5.41	6.02	200.00
Mash	Blue	23.12	4.21	1.26	21.63	0.72	2.77	5.89	4.72	202.00
	Black	23.38	4.25	1.19	22.55	1.81	1.82	6.39	5.58	212.17
	Green	20.94	4.41	0.88	23.24	1.79	3.03	5.16	5.67	221.50
Pellet	White	18.43	3.53	0.76	16.85	4.46	2.01	5.54	4.08	225.17
	Blue	19.47	3.89	0.84	15.94	2.76	2.62	5.36	4.12	227.67
	Black	19.25	3.79	0.95	17.18	2.69	1.67	5.51	4.58	218.67
	Green	17.83	3.71	0.98	16.02	4.03	2.57	6.52	4.93	261.00
	SEM	±1.79	±0.418	±0.13	±0.70	±1.64	±0.36	±0.63	±0.34	±11.03
	p-value	0.99	0.92	0.19	0.44	0.94	0.71	0.31	0.21	0.53

Mean±SEM= Standard Error of Means; [a-c] Means within a column having different superscripts are significantly diffenent (p<0.05)

The result of the feed forms revealed that, all the parameters measured were not significantly (p>0.05) influenced by the feed form. Numerically, highest belly fat weight (3.49 g/kg) and intestinal length (233.13 cm) were observed in birds fed pelletized feed, while least belly fat weight (2.07 g/kg) and intestinal length (208.92 cm) were observed in birds fed mash feed. The highest liver weight (22.21 g/kg), heart weight (4.13 g/kg), gizzard weight (22.85 g/kg). and proventriculus weight (5.49 g/kg) were observed in birds fed mash feed and the least liver weight (18.75 g/kg), heart weight (3.75 g/kg), gizzard weight (16.49 g/kg) and proventriculus weight (4.43 g/kg) were observed in birds fed pelletized feed.

The interaction between the polymer light filter and feed forms, all the parameters measured were not significantly (p>0.05) influenced by the interaction between the polymer light filter and feed forms. Numerically, the highest liver weight (23.38 g/kg) and least liver weight (17.83 g/kg) were observed in birds reared under black polymer light filter and fed mash feed and in birds reared under green polymer and fed pelletized feed respectively. The highest heart weight (4.41 g/kg) was observed in birds reared under green polymer and fed mash feed and least heart weight (3.53 g/kg) was observed in birds reared under white polymer light filter and fed pelletized feed. The highest gizzard weight (23.97 g/kg) was observed in birds reared under white polymer light filter and fed mash feed and least gizzard weight (15.94 g/kg) was observed in birds reared under blue polymer light filter and fed pelletized feed. Birds reared under white polymer light filter and fed pelletized feed had highest belly fat weight (4.46 g/kg) while least belly fat weight (0.72 g/kg) were observed in birds reared under blue polymer light filter and fed mash feed. The highest intestinal length (261.00 cm) and least intestinal length (200.00 cm) were observed in birds reared under green polymer light filter and fed pelletized feed and birds reared under the white polymer light filter and fed mash feed respectively.

4. DISCUSSION

4.1 Environmental and Cloacal Temperature Parameters on Performance of Broiler Chickens

In brooding chicks efficiently, i.e., providing a comfortable, and healthy environment for the growing birds, temperature and light are very important. The result of the environmental temperature and cloacal temperature had effect on the polymer light filter. The environmental temperature, the cloacal temperature and the water intake of birds reared under the blue polymer and fed pelletized feed were the highest. This indicated that the birds were heat stressed similar to the findings of [14] who indicated that indoor air temperature of poultry house should not be above 33 ºC and also [16] that when birds under the tropical and subtropical conditions are exposed to an environment that is consistently hot (over 30°C), they develop stressful behavioral responses to loss heat that are above the critical temperature, such as increased respiration rate, panting, loss of appetite, and altered metabolism. The birds regulated their body temperature by increasing their water intake hence reduced feed intake. These results are in agreement with [17] who indicated that heat stress disrupts the comfort of broilers and drastically reduces their performance, and also studies by [18] who stated that heat stress in broilers causes significant increase in feed conversion ratio. According to [19], broiler birds depend on environmental temperature to maintain optimal body temperature, when the room temperature decreases, the bird's body temperature will decrease and vice versa.

The performance result of birds reared under white polymer was the best but with the highest cloacal temperature (39.63$^{°C}$) which does not coincide with studies by [20-23] who stated that the growth rate, live weight, body weight gain, feed conversion rate and feed intake decrease in broiler with constant heat stress (34$^{°C}$) for more than 14 days. The environmental temperature result of the birds reared under the white polymer was not within the range mentioned by [21-23].

Water intake was positively correlated with rectal temperature in birds reared under white polymer, as the values of cloacal temperature and water intake were highest throughout the study. This result correlates with the report presented by Vaneekeren N et al. and Stanishevshevskaya OL and Fedorava ES [24,11] who stated that one of the ways broilers exchange heat is by increasing their water intake. These results suggest that, higher luminosity stimulated physical activity, the low body temperature allowed better heat exchange, and therefore, there was less need for birds reared under the back polymer light filter to drink water.

The effect of water intake with respect to feed forms revealed that birds fed pelletized feed consumed more water compared to birds fed mash due to the nature of pelletized feed, more water is needed to breakdown pelletized feed to enhance digestibility and absorption by the small intestine.

4.2 Polymer Light Filters Parameters on Performance Broiler Chickens

The ray of light reaching birds in the pen is directly proportional to the color of the polymer light filter during brooding, and vision is one of the main senses that influence broiler chickens. The result of this study indicates that the polymer light filter treatments had effect on the broiler performance. This explains that broiler chickens are more sensitive to light which coincides with the findings of [5] that the capacity of responding to light is a universal aspect of all organism. Birds reared under the white polymer had the best final weight, weight gain, feed intake, water intake and lowest feed conversion ratio which coincides with the studies by Rusty DR [25] that broilers raised under white polymer are more active than those raised under blue and green polymer. Khaliq T et al. [26] revealed that poultry are more sensitive to environmental luminosity than humans. According to [27], broiler showed highest physical activity in bright environments.

The chicks reared under the blue polymer light filter had least feed intake. This result agrees with the report by Khaliq T et al. [26] that blue polymer was found to reduce activity compared to white, green, or red polymer. These results negate the studies by Niekerk TV et al. [28] that the eyes of the broiler chickens are more sensitive to red and blue polymer light filter. The birds reared under black polymer light filter had the highest feed conversion ratio weight which justifies the remark by Pal P et al. [27] that dark environments may have adverse effects on broiler behavior due to of vision impairment.

4.3 Feed Form Parameters on Broiler Performance

The birds fed pelletized feed performed better compared to those fed mash feed. According to Sogunle OM et al. [29], the effect of the particle size of diets on broiler performance is confounded by the complexity of the diet and further processing methods. Pelleting is an expensive process, but its use is justified on the basis of the performance improvements. According to Khalil M et al. [30], pelletizing entails combining smaller feed particles into larger ones in the form of pellets in order to boost feed efficiency and production efficiency by improving feed consumption and digestibility. Chewning CJ [31] demonstrated that feeding broilers pellets or crumble stimulate feed intake which result in higher body weight and improved feed conversion compared with mash diets. According to Abdollahi MR et al. [32], pelleting decrease feed wastage because less feed falls from the beak. Idan F et al. [33] reported that a 7 to 10% higher feed intake in birds fed crumbles compared to those fed mash diets and attributed the higher feed intake to a reduction in selective feeding. Dozier WA et al. [34] stated that feeding broiler pellets against mash diets have attributed the improved performance to decreased ingredient segregation, decreased time, and energy spent during prehension and increased palatability and digestibility of feed. Lv M and Ismail FSA [35,36] concluded that the feed forms had no significant (P>0.05) influence on feed conversion ratio. The results from this study suggests that feeding crumbled-pellet diets increased feed intake which stimulated early chick growth and subsequently improved overall growth performance and feed conversion rate of birds compared with feeding a mash diet.

4.4 Carcass and Organs Parameters of Different Feed Form and Polymer Light Filter

The role of the gastrointestinal tract (GIT) is important, which affects digestive efficiency and health of birds directly and indirectly. A well-developed gizzard enhances the grinding action, generates stronger reverse peristalsis contractions within the GIT. The result from this study revealed that the broiler birds fed mash diet had highest liver weight, proventriculus weight, heart weight and gizzard weight compared to birds fed pelletized feed. This agrees with the remark of [31,37-39] that birds do not fully develop their upper gastrointestinal tract when highly processed pelleted feeds are used, but contrary to the studies by [40,38] that liver weight is greater in birds fed pelletized feed compared to birds fed mash diets. The birds fed pelletized feed had highest value for intestinal length and highest belly fat weight, this does not coincide with the findings of [41] that abdominal fat weight was not influenced by different feed forms. The result of the intestinal length negates the findings of [41] that birds fed mash diet had longer intestinal length.

Polymer light filter had no impact on the organ characteristics of broiler chickens. The result of the liver weight, heart weight, gizzard weight, proventriculus weight and intestinal length was not influenced by the polymer light filter. This conforms to the remark of [15,42] that coloured polymer light filter had no significant (p>0.05) effect on liver, heart and gizzard weights. However, the result of the gizzard weight was not in line with the findings of [43] who indicated that there was significant (P<0.05) effect of gizzard weight under the different polymer light filter.

The result presented in Table 3 showed that carcass characteristics of birds reared under the white polymer light filter performed best in terms of live weight, eviscerated weight and dressed weight, while birds reared under the black polymer had the least values which is consistent with the findings of [26]. The results of the dressed weight are in accordance with [44] that no significant (p>0.05) effect was found on dressed weight of birds reared under different colors of polymer light filter. Also, [15] noted that no significant effect (P>0.05) was found on eviscerated weight of birds reared under different colors of polymer light filter.

The result of the live weight, dressed weight and eviscerated weight of birds fed pelletized feed were better than birds fed mash feed, this agrees with findings by [44,45] that feed forms had effect on carcass parameters of broiler chicken and also observed significant difference (p<0.05) in carcass weight and belly fat between birds fed mash and pelletized feed. The result of eviscerated and dressed weight was not influenced by the interaction between feed forms and color.

4.5 The Interaction between Feed Form and Polymer Light Filter

Performance of broiler birds indicated that birds reared under the blue polymer and fed pelletized feed had the highest value for body weight gain, feed intake, final weight, water intake from other parameters measured. The feed conversion ratio of birds reared under the white polymer and fed pelletized feed was the best.

5. CONCLUSION

It is evident from the results of this study that colors of polymer light filter have an utmost role in broiler production but had no effect on carcass and organs characteristics of the broiler chicken. Birds reared under white polymer light filter had the best production performance although, due to high cost and non-availability of the white polymer light filter, blue polymer light filter could serve as a replacement to white polymer light filter. Feed forms for broiler resulted in significant impact in both production and carcass parameters, birds fed pelletized feed performed better than birds fed mash. Considering the higher growth performance of birds fed pelletized feed, it could be as a result of non-selection of macro/micro ingredients by the birds. It can be concluded that birds fed mash feed form had higher gizzard, liver proventriculus, and heart weight of broiler chickens than pelletized feed. The result of the rectal temperature, environmental temperature and water intake of the bird revealed that broiler regulates their temperature by increasing their water intake.

ACKNOWLEDGEMENT

The authors are grateful to the Research Committee of the Department of Animal Production and Health, Federal University of Technology, Akure, Nigeria for giving the approval to conduct this study and also for approving a space for us at the Teaching and Research Farms (Livestock Section) of the University.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/99382