



INVESTIGATION OF THE EFFECT OF LIGHT COLOURS AND TROUGHS ON GROWTH PERFORMANCE AND BEHAVIOUR OF BROILER CHICKENS

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ABSTRACT

This study was conducted to investigate the effect of light colours and troughs on the growth performance and behaviour of broiler chickens exposed to different colours of light and troughs. A total of 150-day old broiler chicks were randomly allotted into five dietary treatments designated as T₁ to T₅, with each treatment replicated thrice with 30 chicks each in a completely randomized design. T₁ served as control with normal colour of light and trough while birds in T₂, T₃, T₄ and T₅ were exposed to blue, red, white and green colors of light and troughs respectively tallying with the colour of trough in each treatment. The study lasted for 8 weeks during which the effects of different colours of light and troughs were examined. Data were generated on growth parameters and the behaviours of the chickens. Results revealed significant differences ($p < 0.05$) across treatments in final weight, feed conversion ratio and water intake with T₃ having the least values of mortality 0.00% and highest values of 2.22kg and 63.43g in total weight gain and average daily weight gain, respectively. There were also significant differences ($p < 0.05$) observed in their behaviour across all treatments in the values of feed eating, comfort activity, and lying/sleeping with T₁ having the highest value of 0.67% in aggression. It can be concluded that broiler chickens reared under red colour performed better than others while for calmness, blue and green.

Keywords: Effect, Light, Colours, Troughs, Growth, Performance.

INTRODUCTION

Chickens possess normal vertebrate trichromatic vision and can readily be trained to discriminate colours (Bell and Freeman, 1971). They differ from mammals in that light penetrates the skull to influence the hypothalamus and in particular reproduction (Foster and Follet, 1985). Light penetrates through the top of the skull and stimulates pineal gland and hypothalamus. Pineal gland light's sensitivity is used to regulate daily behavior cycles of the birds while hypothalamus regulates their metabolism and reproduction. This is because photoperiod, which is essentially a change in light intensity, is known to influence the growth and behavior of meat chickens (Morris, 1968). It is to be expected that colour, which is essentially a change in intensity at certain wavelengths, would also affect growth and behaviour.

Short wavelengths generally increase body growth and feed efficiency (North and Bell, 1993). These effects of short wavelengths could be explained by the greater penetration of the avian skull by long wavelengths (700 to 750 nm), compared with short wavelengths (400 to 450 nm) (Benoit, 1964; Hartwig and Van Veen, 1979). It is possible that the effects on growth could be explained by stimulation of bird activity by the long wavelength light penetrating the skull, rather than being related to the direct effect of light on hypothalamic gonadotropin production. If activity is increased in long wavelengths and feed conversion efficiency decreased, these responses could explain the adverse effects on growth.



Bird's eyes are the main sense organs, and vision is one of the main senses that influence broilers. Light environments that restrict the efficacy of visual possessing may reduce welfare if important visual information is lost or corrupted by the environment. For example, birds may be unable to recognize important features of other birds, navigate their ways around featureless landscape of poultry house, recognize and respond appropriately to humans, or see their feed and water clearly if vision is lost (Prescot *et al.*, 2003). There are several features of the physical light environment in a broiler pen that may affect the bird's welfare. One of the most important features of the physical light environment of a broiler house that may affect the bird's welfare is the colour of light.

Colour, which is detected by wavelength, exerts variable effects on broiler performance. None of the fluorescent light emits appreciable amount of ultraviolet A light (UVA, 320-409 nm). Day light has a relatively even distribution of wavelengths between 400 and 700 nm (Olanrewaju *et al.*, 2006). One of the most serious welfare problems in broiler production associated with rapid growth is the incidence of skeletal disorders, particularly those that lead to impaired mobility or lameness (European Commission, 2000). Light environment can also affect lameness and mortality through many potential routes; through light intensity, color and photoperiodic regime and indirectly via properties of litter quality (Bizeray *et al.*, 2002).

Chickens have an additional double cone structure that helps them to track movement. Lighting is a powerful exogenous factor in controlling many physiological and behavioural processes. Light may be the most critical of all environmental factors to birds. It is integral to sight, including both visual acuity and colour discrimination (Manser, 1996). Light allows the birds to establish rhythmicity and synchronize many essential functions, including body temperature and various metabolic steps that facilitate feeding and digestion. Of equal importance, light stimulates secretory patterns of several hormones that control, in large part, growth, maturation, and reproduction.

Light is very important for poultry as they are day-active species. Most of their behaviour is mediated by vision (Collins *et al.*, 2011), and they have a better vision in bright than in dim light. Most researches into the effect of color of light on behavior, welfare, and performance have been done on monochromatic light, whereas research into white light with different color temperatures is sparse. A preference for monochromatic blue light has been in broilers reared in blue light preferred green light (Prayitno *et al.*, 1997). Xie *et al.* (2008) suggested that blue light may play a role in level of serum. Blue and green light have been found to have a positive effect on growth in broilers (Rozenboim *et al.*, 1999, 2004). Light of different wavelengths has varying stimulatory effects on the retina and can result in behavioral changes that will affect growth and development (Lewis and Morris, 2000).

Manipulation of lighting programs is a strategy used to reduce the incidence of metabolic and skeletal disorders in broiler chickens. Therefore, light colour has been considered powerful management tool and used for mitigating several stressors in broilers by expressing many physiological, immunological and behavioral pathways (Lewis and Moris, 1998, Xie *et al.*, 2008). It is from the above that this research was aligned to investigate the effect of bulbs and troughs colours on performance, blood profile and performance of broiler chickens.

High light intensity will increase activity, whereas lower intensities are effective in improving production parameters (Gordon, 1994). Exposure of broilers to sub-optimal environmental factors, including temperature, light, diets and gases, among others, during the course of poultry production has an effect on blood physiological variables such as blood acid-base balance, electrolytes, and metabolites (Olanrewaju *et al.*, 2007).



Light is a critical factor which controls physiological function in broilers. There is the need for a farmer to provide alternative light source at night for their growth to be enhanced. Green and blue LED enhances cellular and humoral immune responses in broilers (Xie *et al.*, 2008). Broilers had higher heterophils: lymphocytes ratio and lower antibody titers to Newcastle disease virus in continuous lighting compared with intermittent lighting (Zulkifli *et al.*, 1998; Onbasilar *et al.*, 2007). It has been reported that blue light has a calming effect, red light reduces feather pecking and cannibalism, orange-red light stimulates growth in chickens (Rozenboirn *et al.*, 2004). When alternative source is supplied at night, birds can easily be studied as it affects their behavior and it is on that note that, this research is tailored towards knowing the effect of different light colours on their performance and behaviour.

The aim of this study was to determine the effect of different colours of light and troughs on the growth performance of broilers. The specific objectives of the study were to:

- i. evaluate the effect of different colors on performance of the birds; and
- ii. measure the effect of light on behaviour of the chickens.

MATERIALS AND METHODS

Experimental Location

The trial was carried out at the Poultry unit of the Teaching and Research Farm of Faculty of Agriculture, Ibrahim Badamasi Babangida University, Lapai, Niger State. Lapai is situated on the longitude 9.02°N and latitude 6°34'E of the equator. The farm is located in the Vegetative Zone of Guinea Savannah Middle Belt of Nigeria. It has an average temperature of 23°C-34.4°C and with a minimum rainfall of 107.3mm per annual rainfall. The soil is laterite ferruginous. The main occupation of the people in this location is farming with much abundant land, minority groups go into trading.

Sources and Preparation of Experimental Materials

The maize, salt and wheat offal for feed formulation were bought in Lapai, while groundnut cake (GNC), limestone, soybean meal (SBM) and others were purchased in Minna. The raw soybean bought, was treated with heat and fried until it turns brown to eliminate part of their ant nutritional factors which are heat unstable such as protease inhibitors, lectins (hemagglutinins), and allergens (glycinin and B-conglycinin) which negatively affect the metabolism and health of non-ruminant animals. Electric bulbs of different colours (blue, green, white, yellow and red), and feed and water troughs were purchased from Minna. The colour of feeding and drinking troughs tallied with the colour of light of each treatment.

Experimental Diets

A well formulated (Table 1) experimental broiler starter diet contained 23.05% CP with metabolizable energy 11.73 MJ/kg was served for 4 weeks while the finisher diet containing 19.91% CP with metabolizable energy 11.71 MJ/kg was served from the 5th to 8th week of the experiment.



Table 1: Gross composition of experimental broiler starter and finisher diets

Ingredients	Starter phase (%)	Finisher phase (%)
Maize	46.00	50.00
Soybeans	18.50	12.00
Groundnut cake	15.00	11.00
Fish meal	2.00	2.00
Wheat offal	12.45	19.00
Bone meal	2.00	2.00
Oyster shell	3.00	3.00
Salt	0.25	0.25
Premix ¹	0.25	0.25
Methionine	0.30	0.25
Lysine	0.25	0.25
Total	100	100
Calculated:		
Crude protein (%)	23.05	19.91
ME (MJ/Kg)	11.73	11.71
Ether extract (%)	3.93	3.89
Crude fibre (%)	3.67	3.79
Calcium (%)	1.75	1.74
Phosphorus	0.43	0.41

¹Davo premix Vitamin A (10,000,000 iu), Vitamin D3 (2,000,000), Vitamin E (20,000mg), Vitamin K3 (2,000mg), Vitamin B1 (3,000mg), Vitamin B2 (5,000mg), Niacin (45,000mg), Calcium pantothenate (10,000mg), Vitamin B6 (4,000mg), Vitamin B12 (20mg), Choline chloride (300,000mg), Folic acid (1,000mg), Biotin (50mg), Manganese (300,000mg), Iron (120,000mg), Zinc (80,000mg), Copper (8,500mg), Iodine (1,500mg), Cobalt (300mg), Selenium (120mg), Antioxidant (120,000mg).

Experimental Birds and Management

One hundred and fifty (150) day old chicks were purchased from a reputable farm and raised for eight weeks in a completely randomized design (CRD). The pen was well cleaned, netted and disinfected with Izal[®] before the arrival of the chicks. On arrival, they were served with clean water containing anti-stress. Initial body weight was taken before being allocated into five groups as treatments of three replicate per treatment and ten chickens per replicate (T₁, T₂, T₃, T₄ and T₅). Each treatment was replicated as:

Group 1 (T₁) – Broiler chicks exposed to yellow colour (light and troughs), and served as the control, because is the common colour found across all farms.

Group 2 (T₂) - Broiler chicks exposed to blue colour (light, drinking and feeding troughs),

Group 3 (T₃) - Broiler chicks reared under red colour (light, drinking and feeding troughs),

Group 4 (T₄) - Broiler chicks exposed to white colour (light, drinking and feeding troughs),

and Group 5 (T₅) - Broiler chicks exposed to green colour (light, drinking and feeding troughs).

The colour of light of each treatment tallied with the colour of its feeding and drinking troughs. Each treatment was replicated thrice with wire mesh in-between replicates, and ceiling board between treatment groups. A photoperiod of 12 hour was allowed, and 10 hours of artificial light provided from 7.00 pm to 5.00 am each day. Wood shaves were used as litter



materials. All the pens were identical apart from light environment which differed from one treatment to another. The colour of both light and troughs differ from treatment to treatment. Treatments were separated with plywood and covered with thick black polythene to prevent light rays of a particular treatment from reflecting into another treatment.

Method of Data collection

Performance data were collected on weekly basis throughout the feeding trial. Feed intake was taken and recorded for each treatment per replicate. Feed consumed per bird per week was recorded by subtracting left over from feed supplied.

$$\text{Mean daily feed intake} = \frac{\text{total feed intake}}{\text{number of days}}$$

The average weight gain per bird was obtained by calculating the difference between the final weight gain and the initial weight and was divided by the number of birds.

$$\text{Mean final weight (g)} = \text{mean final weight(g)} - \text{mean initial weight(g)}$$

$$\text{Mean daily weight gain} = \frac{\text{mean final weight gain}}{\text{number of days}}$$

Feed conversion ratio was calculated as the ratio between feed intake and body weight gain.

$$\text{Feed conversion ratio} = \frac{\text{mean daily feed intake (g)}}{\text{mean daily weight gain (g)}}$$

The total number of dead birds during the experiment were recorded and expressed as percentage (%) of the total number of birds alive.

$$\text{Mortality (\%)} = \frac{\text{number of dead birds}}{\text{initial number of stocked birds}} \times 100$$

The scan sampling method of Martin and Bateson (1993) was used in recording the behavioural activities of the birds in each replicate when it was three days to the end of the trial for two hours daily during night time (10.00 pm to 12.00 am) under the respective light environment. An instantaneous observation was made and recorded on 10 categories: walking (moving up and down within the pen), standing (no movement and performing no other type of behaviour), litter eating (pecking and scratching litter on the floor), drinking (beak touching the drinker), eating (pecking feed in the feeder), aggression (leaping towards another bird, frontal threatening, or pecking aggressively), feather pecking (pecking or pulling the feather of another bird), comfort behaviour (stretching, feather ruffling, or wing flapping), lying/sleeping (lying, sitting or sleeping and not engaging in other activities), and dust bathing (pecking and scratching while lying on the side, rubbing the head and body against the floor, or shaking off dirt from the plumage). Each visit to a replicate lasted for 10 – 15 minutes and, observations and recording of their behaviour were made on each bird. Statistical analysis

Data collected were subjected to one-way analysis of variance (ANOVA) according to the procedure of Steel and Torrie (1980). Significant means were separated using Duncan's Multiple Range Test (Duncan, 1955).



RESULTS AND DISCUSSION

Performance Characteristics of Broiler Chickens under Different Colours of Light and Troughs

Results of the performance of the broiler chickens were presented in Table 2. There were significant ($p < 0.05$) differences in final weight, feed conversion ratio and water intake, while other parameters showed no significant ($p < 0.05$) differences. The final weights of birds in treatment 3 were the highest with 2.40 kg, but were not significantly ($p > 0.05$) different from those in treatments 2, 5 and 4 having final weights of 2.39, 2.35 and 2.21 kg, respectively. Birds in treatment 1 (T_1) had the lowest (2.20 kg) final weight. Total weight gain was at the highest (2.22 kg) in T_3 , followed by those in T_2 (2.21 kg), while birds in T_4 had the lowest (2.02 kg). The best feed conversion ratio (FCR) of (1.38) was recorded among birds in T_3 , followed by those in T_2 (1.40) and T_5 (1.43). Birds in T_2 had the highest (19.51 l) water intake, followed by those in T_3 (18.71 l), and T_4 (18.07 l), while the lowest was recorded by birds in the control (T_1). Feed intake was at the highest (3.10 kg) in birds in treatment 5 (T_5), followed by those in T_2 (3.09 kg) and (3.07 kg) in treatments T_1 , T_3 and T_4 .

Table 2: Performance characteristics of broiler chickens subjected to different colours of light and troughs

Parameter	T_1	T_2	T_3	T_4	T_5	SEM
Initial weight (g)	168.53	179.37	180.90	186.97	177.23	0.46
Final weight (kg)	2.20 ^a	2.39 ^b	2.40 ^b	2.21 ^{ab}	2.35 ^b	0.01
Total weight gain (kg)	2.03	2.21	2.22	2.02	2.17	0.14
Average daily wt. gain (g)	58.00	63.14	63.43	57.71	62.00	0.28
Feed intake (kg)	3.07	3.09	3.07	3.07	3.10	1.49
Average daily feed intake (g)	87.70	88.42	87.79	87.59	88.58	0.12
Feed conversion ratio	1.51 ^b	1.40 ^a	1.38 ^a	1.52 ^b	1.43 ^a	0.05
Water intake (litre)	15.58 ^a	19.51 ^c	18.71 ^{bc}	18.07 ^{bc}	17.52 ^b	0.01
Mortality (%)	3.33	3.33	0.00	6.67	3.33	0.00

^{a, b, c}: Means with different superscripts on the same row differ significantly ($p < 0.05$). SEM = Standard Error of Means; Key: T_1 = yellow colour (Control); T_2 = blue colour; T_3 = Red colour; T_4 = white colour, T_5 = Green colour.

Behaviour of Birds Fed Under Different Colour of Lights and Troughs

Table 3 showed results of broilers' behaviour raised under different colours of light and troughs. There were no significant ($p < 0.05$) differences in all behavioural activities except in feed eating, comfort activity and lying/sleeping where there were significant ($p < 0.05$) differences among the treatments. Broilers reared under yellow colour (T_1) were more into walking with the highest value of 1.33%. However, those reared under red colour (T_3) were more in standing with the highest value of 2.67%. Birds exposed to white colour (T_4) ate more litter than other treatments with the highest value of 2.67%. Comfort activity and lying/sleeping behaviours were higher among birds exposed to blue (T_2) and green (T_5) colours and differed significantly ($p < 0.05$), but were observed eating less than other treatments. Based on the results



obtained from this research it is observed that birds under yellow colour (T₁) were more aggressive, while those exposed to blue colour (T₂) pecked more feathers than others.

Table 3: Behaviour of some broilers kept under different colours of light and troughs

Parameter	T ₁	T ₂	T ₃	T ₄	T ₅	SEM
Walking	1.33	0.67	1.00	1.00	1.00	0.99
Standing	2.00	0.67	2.67	1.00	1.67	0.43
Litter eating	2.33	1.33	0.33	2.67	1.33	0.62
Drinking	0.67	1.33	1.66	1.67	0.67	0.48
Feed eating	20.67ab	20.33ab	22.00 ^b	22.00 ^b	20.33 ^a	0.04
Aggression	0.67	0.00	0.00	0.33	0.00	0.53
Feather pecking	0.67	1.67	0.67	0.00	0.00	0.39
Comfort activity	11.33 ^b	12.00 ^b	10.67 ^a	10.00 ^a	11.67 ^b	0.06
Lying/sleeping	60.33 ^a	62.67 ^b	60.33 ^a	61.33 ^{ab}	62.33 ^b	0.05
Dust bathing	0.00	0.33	0.67	0.00	1.00	0.23

^{a, b, c}: Means with different superscripts on the same row differ significantly ($p < 0.05$). SEM = Standard Error of Means; Key: T₁ = yellow colour (Control); T₂ = blue colour; T₃ = Red colour; T₄ = white colour, T₅ = Green colour.

Body weight gain of the broilers subjected to the red light and red troughs (T₃), had the highest body weight gain value (2.22 kg) followed by those subjected to blue colour (T₂) and green colour (T₅) with 2.21 kg and 2.17 kg, respectively. These results agreed with the report of Mohamed *et al.* (2017) who reported beneficial impact on growth performance of broilers reared under three monochromatic led lights (white, green and blue). This finding is also in line with Senaratna *et al.* (2008) who reported that broilers reared under red colour light showed a tendency to gain higher body weight compared to those reared under white light. Birds in blue, red and green light and troughs had positive effect on total body weight and these are in agreement with the report of Olanrewaju *et al.* (2006). The results of the present study revealed that birds fed under red and blue light colours (T₃ and T₂) performed best in terms of final weight gain, followed by green light colour (T₅). The result partly disagreed with the findings of Rozenboim *et al.* (2004) that birds exposed to blue or green light became significantly ($p < 0.05$) heavier than those exposed to white or red light. In this study, birds subjected to red light consumed more feed than other birds. This was followed by birds fed under blue light and troughs (T₂). This statement is closely in agreement with that of Mohamed *et al.* (2017) who observed that feed consumption for birds exposed to blue and green light compared to white light. From the results obtained from this study, it was observed that there were significant ($p < 0.05$) differences in feed conversion ratio among the five treatments, although birds in T₃ (red colour) had the best (1.38). This is contrary to the reports of Prayitno *et al.* (1997) and Classen *et al.* (2004) that there were no significant ($p < 0.05$) differences among colour treatments (blue, green, red, white) on final body weight and feed conversion ratio (FCR). The result from this research on feed intake contradicted the submission of Mousa-



Balabel *et al.* (2017) that broilers kept under white light recorded the highest values but, agreed with the report from the same authors that birds under white light recorded the highest percent mortality. The best and lowest feed conversion ratio (FCR) recorded in birds under blue light (T_3) is in agreement with the report of Cao *et al.* (2008). Water intake, throughout the research, of the birds exposed to blue colour (T_3) was higher (19.51 l) than those exposed to other colours.

The higher values recorded among birds exposed to red colour in feed eating and standing behaviours were in line with the report of Prayitno *et al.* (1997) that broiler birds drinking behavior increased under red light condition. The results also agreed with the report of Atapattu, and Wickramasinghe (2007) that greater intake of water was recorded in broilers exposed to red light. Birds under green and blue colours exhibited more of calm and resting/sleeping behaviours than any other treatments. This is in line with the report of Prayitno *et al.* (1997) who reported that green or blue light induced a calming effect on birds and that they spent more time in sitting or dozing and, more of comfort behavior. The calming and comfortable effects in broilers exposed to blue and green colours in this present research were in line with the report of Senaratna *et al.* (2016) that blue or green light is preferable to red or white light for table birds because it keeps the bird's calmer.

CONCLUSION AND RECOMMENDATIONS

It can be concluded from this research that red, blue and green colours had positive and beneficial impact on growth performance of the broiler chickens. The colours are beneficial as they improved the body weight gain and may serve as potential replacements for other colours in broiler production. It can also be concluded that commercial poultry farmers can use blue, red or green colours aggressiveness and excessive activities in broiler chickens. Based on the findings from this study, raising birds under red and white colour of lights and troughs is recommended but preferably if red colour of feeders and drinking troughs are chosen irrespective of the two recommended light in this research. This is because birds find red colour troughs attractive when feeding and drinking.

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