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BEHAVIOURAL RESPONSE AND WEIGHT OF BROILER CHICKENS REARED UNDER DIFFERENT ARTIFICIAL LIGHT SOURCES

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ABSTRACT

This study evaluated the behavioural response and weight of broiler birds at the 4th and 6th week of age when raised under incandescent (ICD) and compact fluorescent light (CFL). At 2 weeks of age, a total of 216 Arbor Acres birds were randomly allotted into 3 treatments: Control (no artificial light), ICD (60 watts, 800 lm) and CFL (40 watts, 2000 lm). Artificial lighting was provided from 8 p. m. to 4 a. m. daily. Data collected were subjected to One-way ANOVA using Minitab 17 through a general linear model (GLM) procedure and means were separated using Tukey's test software. At 4 weeks of age, the presence of light significantly increased ($P < 0.05$) the weight, as well as the occurrence of feeding, drinking, sitting, standing, walking, running and jumping behaviour. ICD and CFL had similar effects on feeding and jumping behaviour. At 6 weeks of age, the presence of light had no significant effect ($P > 0.05$) on the frequency of drinking and jumping behaviour. However, the weight, the frequency of feeding, standing, walking and running behaviour increased ($P < 0.05$) under the two light sources compared to the control. Also, birds raised under CFL displayed a higher frequency ($P < 0.05$) of inactive/resting and locomotor behaviour compared to birds reared under ICD which had a higher frequency of drinking behaviour. From this study, the use of CFL throughout the production stages is encouraged in poultry facilities due to the resultant increase in the activity levels of broilers and the reduced energy cost.

Key words: artificial light behaviour; broiler; compact fluorescent light; incandescent light; weight

INTRODUCTION

It has been demonstrated that a relationship exists between animal welfare, animal behaviour and the environment [9]. Light is the most important of all environmental factors to broilers [18], and management tool in modifying broiler behaviour because it influences the brain organization that influences the behavioural reaction [12] and capacity to adapt to stress. Light is characterized by source, intensity, wavelength range and length of the photoperiod [16]. Broiler behaviour is categorized into consummatory behaviour, comfort behaviour, locomotor behaviour, social behaviour, inactive behaviour, and aggressive behaviour, exploratory/foraging and reproductive behaviour [10]. The consummatory behaviour includes feeding and drinking. Feeding behaviour in broiler birds seems to be regulated only by satiety mechanism in contrast to hunger mechanisms in red jungle fowl, this may be attributed to intense selection for fast growth through different breeding programs [4].

In the past, incandescent lights (ICD) of various sorts and intensities have been utilized in poultry houses because of their low price [18], yet are at present, being eliminated because of their moderately high power utilization. Poultry farmers have been changing to more energy-efficient light [24] like fluorescent light, particularly the compact fluorescent light (CFL). CFL offers a lower dimension of energy utilization for a comparable light output [8], is less expensive [18], lasts longer, and does not transmit ultraviolet light. Studies have been carried out to identify the light sources that enhance consummatory, locomotor and inactive behaviour in laying birds [6, 18, 22, 23], but researches are scarce on the effect of these light sources on broiler chicken behaviour. Some of the behavioural studies carried out on broiler chickens tend to focus more on light intensities, light spectrum, housing conditions etc., rather than on the light source [2, 3, 5, 7, 20, 21]. Since compact fluorescent light is the available alternative to incandescent bulbs used in Nigeria poultry farming, it is imperative to evaluate the behavioural responses of broiler birds reared under these two light sources, and making more scientific information available in this regard as it has already been reported by Adeleye et al. [1] that the presence of artificial lighting in the evening (8 p. m. to 4 a. m.) in poultry houses enhances the feeding and drinking of broiler birds which in turn improves the conversion of feed to meat within a short period.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at the Teaching and Research Farm, Federal University of Agriculture Abeokuta, Ogun State, Nigeria, with latitude 7°13'27"N and longitude 3°25'29"E and an altitude of 76 m above sea level. The experimental site was located in the rain forest vegetation zone of south-western Nigeria. The area was characterized by a humid climate, a mean annual rainfall of about 1037 mm, as well as a mean temperature and humidity of 34.7 °C and 83 %, respectively (Google Earth, 2020).

Experimental animals

Two hundred and sixteen (216) day-old broiler chicks of Arbor Acres strain were used for this study. The chicks were brooded for two weeks using rechargeable lamps as a light source and the birds were fed *ad libitum* throughout the experiment with commercial feed. Broiler starter feed with crude protein (CP) of 23 % and metabolizable energy of 2800 kcal.kg^{-1} was fed between 0—4 weeks of age, while broiler finisher with crude protein of 18 % CP and metabolizable energy of 3000 kcal.kg^{-1} was fed between the weeks of 5—6. All vaccinations and medications were administered as and when due. After 2 weeks of brooding, the birds were randomly distributed into three experimental treatments.

Experimental treatments

A completely randomized design (CRD) was used to assign birds to the different light sources; control (without artificial light), incandescent (ICD, 60 watts, 800 lm), compact fluorescent light (CFL, 45 watts, 2000 lm) from 2 weeks of age (post-brooding). The bulbs (Philips Gls ICD 60 W bulb and HL011906-2, China Full spiral 80 W CFL Energy Saver) were purchased based on what was available to farmers in the south-west, Nigerian local market. The birds were randomly distributed into 3 treatments. Each treatment was assigned 72 birds which were balanced for weight. The treatments were further divided into six replicates with each replicate containing twelve (12) birds. The housing system used was a deep litter system with each replicate having a dimension of 150 cm by 90 cm. Lights were on at night from 8 p. m. to 4 a. m. daily, while birds were allowed access to natural lighting during the day. Each treatment was demarcated to prevent light penetration from one into another.

Weight measurement

Weekly weight of the birds was determined during the study to monitor the weight changes.

Behavioural recordings

With the aid of an eight (8) units Closed-Circuit Television (CCTV) with infrared cameras embedded, behavioural recordings were done. The infrared was necessary to capture the control group which had no light source. At the 4th and 6th weeks of age (starter and finisher phase), the frequency of bird's feeding, drinking, sitting, standing, walking, running, jumping behaviour were recorded throughout the artificial lighting period (3 consecutive days recording per week). Behavioural recordings were watched on an hourly basis by adopting a scan sampling method of 10 min interval using an ethogram (Table 1).

Statistical analysis

One-way analysis of variance (ANOVA) was used to analyse the effects of treatment on behavioural expressions as well as the birds' weight at the 4th and 6th week of age. This was done using Minitab 17 [17] through a General linear model (GLM) procedure, and separation of means was done using Tukey's test; $P < 0.05$ was considered statistically significant.

Ethical considerations

The study was approved by the Departmental Ethical Committee (FUNAAB-APH17-02).

RESULTS

Effect of light sources on the mean frequency of behavioural pattern of broiler birds

The frequency of occurrence of all of the behaviour (feeding, drinking, sitting, standing, walking, running and jumping) in the birds were influenced by the presence of light at week 4 (Table 2). Birds subjected to ICD and CFL had significantly ($P < 0.05$) higher drinking and feeding

Table 1. An ethogram describing the behaviour of birds observed during the study

Consummatory	Feeding	Head extended towards available feed resource while beak appears to be ingesting feed
	Drinking	Beak in contact with drinking water
Inactive/Resting	Sitting	Abdomen touching the litter
	Standing	The bird is motionless with no apparent movement of legs
Locomotory	Walking	Moving forward taking one or more steps
	Running	Walking very fast
	Jumping	Lifting both feet away from the litter. No part of the body is in contact with the litter

Adapted from: Villagrá et al. [22]

Table 2. Effect of CFL and ICD light sources on the mean frequency of behaviour of broiler birds (week 4)

Behavioural categories	Parameters	Control	ICD	CFL	SEM	P value
Consummatory	Feeding	3.35^{b}	5.09^{a}	5.63^{a}	0.69	0.00
	Drinking	2.15^{b}	2.87^{a}	$2.50^{a,b}$	0.21	0.02
Inactive	Sitting	7.88^{a}	5.51^{c}	6.82^{b}	0.69	0.00
	Standing	0.42^{c}	0.90^{b}	1.70^{a}	0.36	0.00
Locomotor	Walking	3.99^{c}	6.09^{b}	7.11^{a}	0.92	0.00
	Running	0.01^{c}	0.46^{b}	1.07^{a}	0.31	0.00
	Jumping	0.03^{b}	$0.04a^{b}$	0.07^{a}	0.01	0.04

Mean values that do not share the same superscripts across the rows differ significantly
ICD—Incandescent; CFL—Compact Fluorescent Light; SEM—Standard Error of Mean

Table 3. Effect of CFL and ICD light sources on the mean frequency of behaviour of broiler birds (week 6)

Behavioural categories	Parameters	Control	ICD	CFL	SEM	P value
Consummatory	Feeding	2.31^{b}	3.35^{a}	3.62^{a}	0.40	0.00
	Drinking	1.94	2.11	1.70	0.12	0.11
Inactive	Sitting	6.74^{a}	4.97^{b}	5.61^{b}	0.52	0.00
	Standing	0.16^{b}	0.30^{a}	0.35^{a}	0.06	0.00
Locomotor	Walking	2.49^{b}	3.17^{a}	3.56^{a}	0.32	0.00
	Running	0.00^{c}	0.11^{b}	0.20^{a}	0.06	0.00
	Jumping	0.02	0.03	0.02	0.01	0.09

Mean values that do not share the same superscripts across the rows differ significantly
ICD—Incandescent; CFL—Compact Fluorescent Light; SEM—Standard Error of Mean

frequency relative to those in the control group. The frequency of standing, walking, running and jumping exhibited by birds subjected to CFL was significantly higher ($P < 0.05$) than the control.

At week 6, drinking and jumping behaviour exhibited by birds were not affected by the presence of light (Table 3). The frequency of occurrence of feeding, sitting, standing, and walking behaviour of birds reared under ICD and CFL were similar. However, birds subjected to CFL exhibited a higher frequency of running behaviour.

Effects of light sources on hourly occurrence of consummatory behaviour

The average feeding frequency of broiler birds based on hours under different light sources at week 4 is shown in Figure 1. Under both light sources, the peak of feeding frequency was observed at 9 p. m. and the least at 1 a. m. The average feeding frequency of broiler birds on an hourly basis at six weeks of age is shown in Figure 3. Across all treatments, the least of the average feeding frequency was observed at 8 p. m. and the peak at midnight. The presence of light influenced feeding behaviour compared to the control, but the frequency of feeding behaviour exhibited by birds under the light sources was very similar.

Average drinking frequency on an hourly basis at week 4 is shown in Figure 2. Birds under ICD light showed a higher drinking frequency over others, except at 1 a. m., 3 a. m. and 4 a. m. while the control has the lowest drinking frequency from 10 p. m. till 4 a. m.

At six weeks of age, there was a steady increase in the drinking frequency of birds raised under ICD as shown in Figure 4. The expression of the behaviour reached its peak at midnight followed by a sharp decline.

Effects of light sources on the weight of broiler birds

Presented in Figures 5 and 6 is the total weight of the birds at the 4th and 6th week of the experiment, respectively. Birds reared under both artificial light sources had significantly ($P < 0.05$) higher weight than those in the control treatment. Birds subjected to both light sources had similar weights.

DISCUSSION

In this experiment, the presence of light influenced the frequency of feeding and drinking behaviour in birds. Birds raised in the control group under no artificial light exhibited less feeding and drinking behaviour as compared to those raised during the night under the two light sources (ICD and CFL), with a higher rate of feeding and drinking. The results of this study agree with the findings of Mohammed et al. [18], who noted that the presence of artificial light increased the frequency of feeding behaviour during the night. Birds may have been motivated to perform consummatory behaviour due to the presence of light which might have enhanced visualization of the feeders and drinkers. The frequency of the occurrence

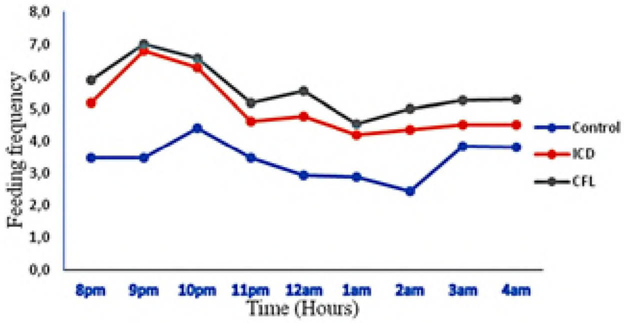

Fig. 1. Hourly average frequency of feeding behaviour of birds under control, ICD and CFL at 4 weeks
ICD—Incandescent; CFL—Compact Fluorescent Light

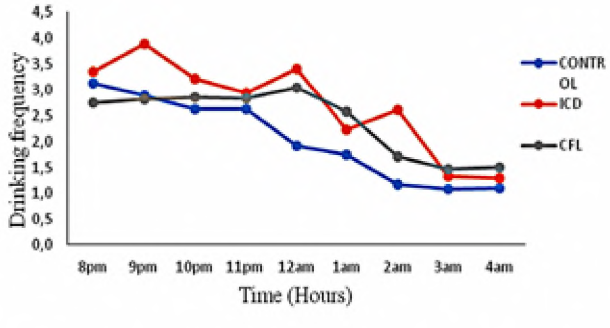

Fig. 2. Hourly average frequency of drinking behaviour of birds under control, ICD and CFL at 4 weeks
ICD—Incandescent; CFL—Compact Fluorescent Light

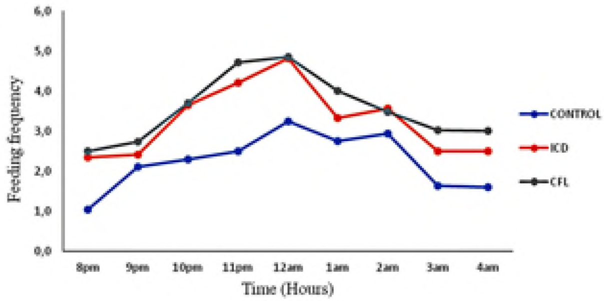

Fig. 3. Hourly average frequency of feeding behaviour of birds under control, ICD and CFL at 6 weeks
ICD—Incandescent; CFL—Compact Fluorescent Light

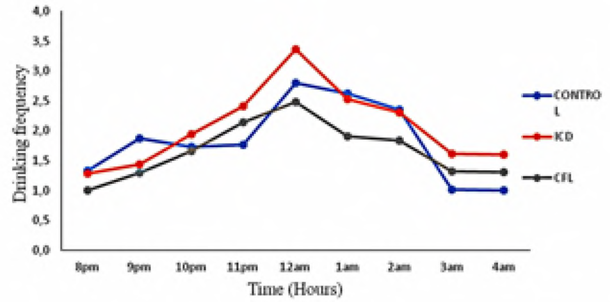

Fig. 4. Hourly average frequency of drinking behaviour of birds under control, ICD and CFL at 6 weeks
ICD—Incandescent; CFL—Compact Fluorescent Light

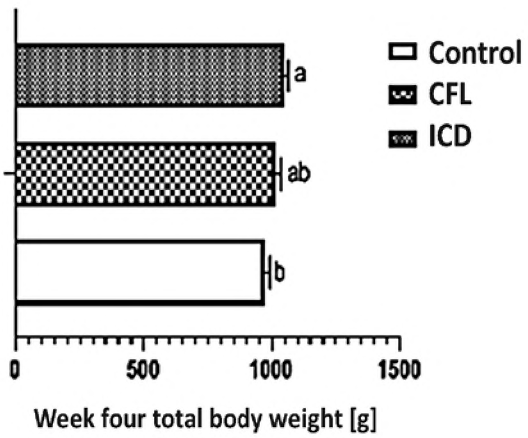

Fig. 5. Total weight of birds under control, ICD and CFL at 4 week of age
ICD—Incandescent; CFL—Compact Fluorescent Light

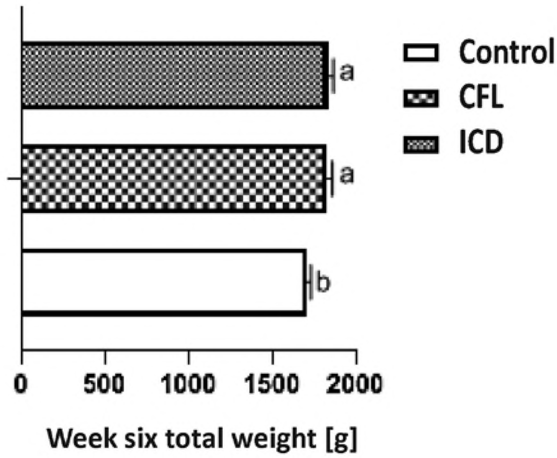

Fig. 6. Total weight of birds under control, ICD and CFL at 6 week of age
ICD—Incandescent; CFL—Compact Fluorescent Light

of feeding behaviour in broiler birds reared under ICD and CFL were similar. This result aligned with the research of Vanderberg and Widowski [23], who found that although the presence of light influenced the feeding behaviour, the differences observed in the frequency of the feeding behaviour of birds under the light sources were negligible. This also further supported researchers who also noted that minor differences were observed in the feeding behaviour of laying birds under different light sources [18, 22]. Therefore, none of the light sources highly influenced the feeding behaviour better than the other. The average hourly frequency of feeding behaviour exhibited by birds showed the response of birds in each treatment from 8 p.m. to 4 a.m. For birds at 4 weeks of age, the feeding frequency based on hourly average. Figure 1 revealed that birds reared under both light sources exhibited a higher frequency of feeding behaviour when compared to the controls. Under both light sources, the peak of occurrence of the feeding behaviour was observed in the second hour (9 p.m.). This observation could be attributed to an increase in bird's activity at the onset of lighting. The feeding pattern in the control group almost appeared to be consistent with the other groups. The reason(s) for this remains unclear, but since the animals were supplied with feed simultaneously, one would expect the animals to access the feed almost immediately. At the 6th week of age, the frequency of feeding behaviour was similar under both ICD and CFL and the feeding frequency (Figure 3) peaked across all treatments at midnight.

At 4 weeks of age, the frequency of drinking behaviour exhibited by birds reared under ICD was higher compared to the controls. A possible explanation for this might be as a result of the heat dissipated by ICD against CFL bulb type. For a given quality of light, ICD produces more heat, thus necessitating a need for thermoregulation. Surprisingly in the 6th week, the presence of light did not influence the frequency of drinking behaviour in birds, that is, no difference was found in the drinking behaviour of the broiler birds raised in the control group (without any artificial light) and those raised under the two different light sources. A possible explanation for this might be that since the locomotor behaviour is generally reduced at 6 weeks (due to age and weight), the frequency at which birds visited drinkers reduced generally across treatments. The bird's frequency of drinking based on an hourly average (Figure 4) showed the response of birds in each treatment from 8 p.m. to 4 a.m. At 4 weeks of age across all treatments, birds exhibited a high frequency of drinking behaviour at the onset of lighting and a low frequency at the end of the lighting period. The reason behind this observation remains unclear. However, it appears as though, the bird drinks more frequently at a young age than when they are old as the mean frequency at 6th week dropped numerically at this age. This is because the reduced mean frequency of drinking did not attain statistical significance. The fluctuation in the behavioural expression of birds reared under ICD could be a result of heat dissipated by the bulb. Generally, at week 6, the frequency of drinking behaviour increased from the onset of artificial light, and the peak was observed at the fifth hour (midnight) before a decline. The midnight peak was due to the refilling of the birds' drinkers that took place every midnight during the study.

The impact of the consummatory behaviour was reflected in the weight of birds measured at the 4th and 6th week of life. Higher weights were recorded in birds raised under both artificial light sources when compared to the control group. Birds reared under both light sources had similar weight. This is in accordance with the findings of Ghuffar et al. [13] who observed no significant difference in the mean body weight of broilers housed under ICD and fluorescent light, and Ingram and Hatten [14] whose report on light restriction in broilers showed the lowest mean weight gain in birds with restricted lighting regimen in broilers.

The occurrence of inactive behaviour (sitting and standing) was greatly influenced by the presence of light. The frequency of sitting behaviour exhibited by birds supplied with artificial light was reduced when compared to control, thus the absence of light enhanced sitting behaviour. This can be explained by the fact that the presence of light motivated birds to perform physical activities, thus the frequency of sitting behaviour was reduced under the light sources. In contrast, the frequency of standing behaviour exhibited by birds in the treatments supplied with artificial light increased. A possible explanation for this is that the absence of light inhibited the expression of standing behaviour. Birds that were reared without artificial light performed more of sitting and less of standing behaviour, while those reared under artificial light performed more of standing and less of sitting. At 4 weeks, a higher frequency of sitting and standing behaviour in birds reared under CFL compared to those under ICD, further support the idea of M o h a m m e d et al. [18], who reported that sitting behaviour was lowest for birds raised under ICD light albeit with different intensity. Since birds raised under CFL performed more inactive/resting behaviour than those under ICD, this may be because there was a need for a counterbalance for the energy expended on physical activity, by resting. At 6 weeks, the frequency of sitting and standing behaviour exhibited by birds under ICD and CFL were similar. This supported the study of K r i s t e n s e n et al. [15] who stated that sitting behaviour was not influenced by light sources. M o h a m m e d et al. [18] also reported that light sources do not affect standing activity in birds. A possible explanation for this is that, regardless of the light source, the time spent resting (sitting) increased as broilers grew older, which is thought to be another consequence of increased body size and decreased mobility [4, 26].

The frequency of occurrence of locomotor behaviour was improved by the presence of light. Broiler birds raised with artificial light exhibited a higher frequency of walking, running, and jumping behaviour compared to those in the control group. This might be due to the presence of light facilitates birds' vision and act as a motivation to perform locomotor behaviour. It is worthy of note, that at 6 weeks, jumping behaviour was not influenced by the presence of light, and this could be due to an increase in age and body weight. Another important finding was that at the 4th week, higher frequency of walking and running behaviour was exhibited by birds reared under CFL when compared to those raised under ICD. The frequency of jumping behaviour exhibited by birds under CFL was higher when compared to the control group. These present findings are consistent with other researches, which revealed that physical activities are higher under CFL than ICD [6, 18]. A possible explanation for this result might be the high luminous efficacy (2000 lm) of 40 watt CFL compared to 60 watt ICD (800 lm) used during these experiments. Luminous efficacy ($lm.w^{-1}$) is the brightness of the light produced by a bulb. Activity levels of birds are known to be positively correlated to light intensity [6, 11]. Low light intensity reduces activity [20], and brighter light fosters increased activity level in broiler birds [19]. Although, at 6 weeks of age, the frequency of occurrence of walking behaviour exhibited by birds raised under ICD and CFL was very similar. This may be because regardless of the light source, as the body size of broiler birds increases, mobility decreases [25].

CONCLUSIONS

This study allowed us to conclude that the use of CFL increased the activity levels of broiler chickens during the 4th and 6th weeks of age as revealed by the mean frequency of the locomotor behaviour, while the drinking behaviour was exhibited more by birds under the ICD light source. Furthermore, the weight of broiler chickens during the 4th and 6th weeks of age was significantly improved by the use of artificial light in the rearing facility.

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CONFLICT OF INTEREST

All the authors declare no known conflict of interest.

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