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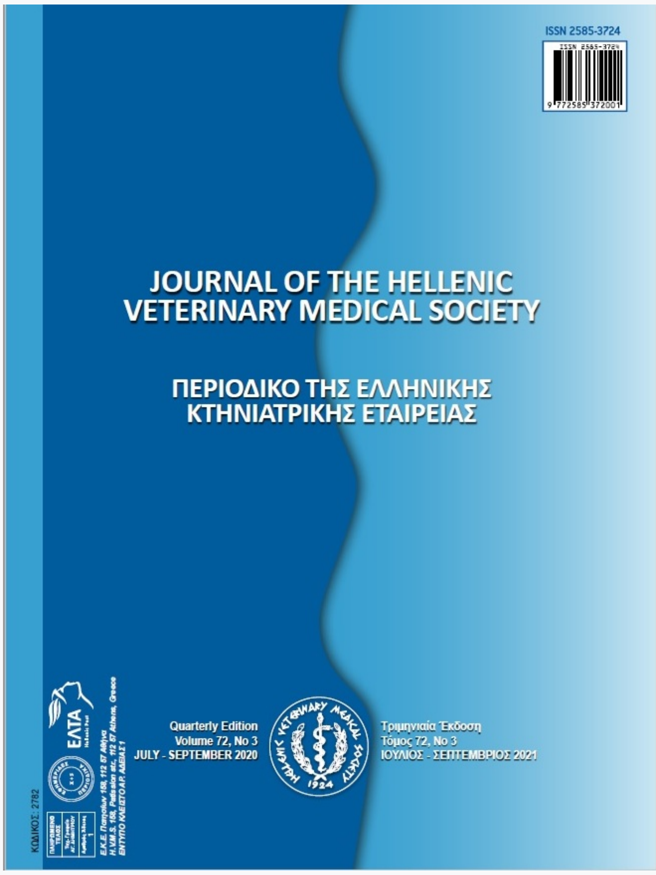

Dim blue light colour reduces the activities and improves the performance of Indian River broilers under Egyptian conditions

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Research article
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Dim blue light colour reduces the activities and improves the performance of Indian River broilers under Egyptian conditions

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ABSTRACT: Poultry producers accustomed to use light colours in broiler production as atrial to increase their productivity, especially in the developing countries to cover the animal protein gap. This experiment was planned to study the effect of different blue light colour intensities (high, medium and dim) on a recently imported Indian River (IR) broilers to Egypt. In this study, 270 one-day old Indian River broiler chicks were used. The birds were exposed to high blue light intensity (HBLI), medium blue light intensity (MBLI) and dim blue light intensity (DBLI), through a monochromatic lighting system that was installed in different rooms for 24 hours daily. The birds were randomly divided and housed into three well controlled pens of 5.46 m^2 with three replicates of 30 each using a density of 17 birds/m^2 in the room. The results showed that the broilers reared under DBLI had a significantly ($p< 0.05$) higher body weight, body weight gain, Newcastle disease virus antibody titer and foot pad dermatitis with obviously, economic Feed conversion ratio (FCR) and low activities and heterophyil/lymphocyte ratio in comparing with (MBLI) and (HBLI). In conclusion, poultry producer can use dim blue light in their farms to reduce the activities and increase the productivity of the birds.

Keywords: behaviour; blue light; IR broilers; light intensity.

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INTRODUCTION

Nowadays, the search for good welfare conditions is a global tendency in animal production (Moura et al., 2006). The transition from backyard to intensive poultry production was done to overcome the animal protein gap in most of the developing countries.This contributes can be done by manipulating and modulating the critical environmental items such as, light intensity and light colour as it controls many physiological and behavioural processes (Olanrewaju et al., 2006). As, the light helps in the establishment of circadian rhythms and synchronization of various essential physiological functions that influence the growth (Manser, 1996) and improve the poultry welfare (Mousa-Balabel et al., 2017).

The Indian River (IR) broiler has recently been introduced to Egypt, and debate persists about the perfect regime of light intensities and colour is unknown. The preferences of broilers to light intensity differed according to their age (Davis et al., 1999).The light intensity and wavelength affected the broilers behaviour due to the different preferences of birds to the type of light spectra and illuminant used (Barber et al., 2006: Kristensen et al., 2007). Generally, using of brighter lighting results in increased bird activity. But, the use of lower light intensities can help in the controlling of aggressive actions (Olanrewaju et al., 2006). Regarding the broiler performance under different light wavelength, it has been reported that the green and blue lights stimulate the growth, while red light boosts the pecking (Rozenboim et al., 2004). Moreover, the use of monochromatic green light accelerates the muscle growth (Halevy et al., 1998). Several studies show that broilers kept under blue or green light colours were significantly heavier in the body weight than those reared under red or white light (Rozenboim et al., 2004; Mousa-Balabel et al., 2017) without any significant impacts on total feed intake, food conversion ratio and mortality percent (Cao et al., 2008).

The behavioural expression was found to be reduced when exposed to dim light intensity as found by Alvino et al. (2009) for 5 lux and Newberry et al. (1988) for 6 lux *vs.* 180 lux. The authors concluded that the failure of high intensity blue light to increase standing and walking acts indicates that the pineal gland's sensitivity to long wave length light is essential to affect the bird activity.

In addition, broilers were found to be more active at high light intensity (30 lux) (more ground pecking, wing stretching and walking) than at low light intensity (10 lux). Further, rearing broilers in bright light early in life increased activity and reduced leg disorders (Prayitno et al., 1997). In addition, the implications of blue light intensity on IR broiler behaviour and bird welfare remain relatively unknown. Thus, this study was carried out to shed light on the beneficial effect of different blue light colour intensities (high, medium, dim) on the performance, behaviour and welfare status of IR broilers under Egyptian conditions to achieve the optimum one.

MATERIALS AND METHODS

Birds, experimental design and diet

The present study was conducted under the temperate climatic conditions of Kafrelsheik Governorate, Egypt, during the months of February and March, 2019. In this study, two hundred and seventy unsexed day old commercial Indian River (IR) broiler chicks were well selected and obtained from a reputable local commercial hatchery in El-Gharbyia Governorate, Egypt. Their average body weight was 44 ±2.3 gand brooded under standard brooding conditions (All birds were kept under an intensity of 40 lux and 24 h light length from 1 to 7 days of age) according to Mousa-Balabel et al. (2017). After 7 days of age, the light-dark cycle was 23 hours:1 hour. From d 8 to d 35 of age, the chicks were randomly distributed into3 equal separate environmental light proof rooms (2.6X2.1m each) with three replicates of 30 chicks each.

The birds were exposed to 3 different blue light intensity (BLI) treatments of incandescent bulb following their identification with wing rings according to Senaratna et al. (2016). The chicks in the first pen (90 chicks) were reared under high intensity (320 lux) of blue light colour (HBLI). While, the chicks in the second pen (90 chicks) were kept under medium intensity (20 lux) of blue light colour (MBLI) and the chicks in the third pen (90 chicks) were kept under dim (low) intensity (5 lux) of blue light colour (DBLI). These treatments were used to assess the effect of various intensities of blue light colours (high, medium and dim) on IR broiler performance and behaviours under the Egyptian conditions with a trial end stocking density of 34 kg/m^2 (equivalent to 17 chicks /m^2) based on chick placement numbers (Rozenboim et al., 2004). Throughout the duration of the study, all birds in the different treatments were given identical care and management (Xie et al., 2008). The chicks were grown on a deep litter system with *adlibitum* water and fed on a commercial ration (El-Wadi Company, Egypt); broiler starter (metabolizable energy [ME] = 3,000 kcal/kg, crude protein [CP] = 23%); broiler finisher (ME = 3,100 kcal/kg, CP = 20%). The starter ration was used for feeding all broiler chicks from day 1 to day 21 of age and the finisher ration was used for feeding all broiler chicks from day 22 to day 35 of age. The light intensity was recorded three times weekly at the bird's eye height from different three positions in each experimental room using lux meter (Conrad, Hirschau, Germany) to guarantee approximate light intensity which altered due to the dust accumulation on the light bulbs.The dimming bulbs were done by dimmer switches.

Newcastle disease virus (NDV) vaccine (Pfizer Company, Egypt) was administered twice in the drinking water at 7 and 17 days old using live vaccine strains. All procedures performed in the study involving birds were in accordance with the ethical standards of the Animal Care and Ethics Committee of the Faculty of Veterinary Medicine, Kafrelsheikh University, Egypt, at which this study was conducted.

Data collection

At the day of birds arrival, the body weight (BW) of the birds was recorded individually and subsequently at the end of each week. Body weight gain (BWG), total feed intake (TFI) and water intake (WI) were calculated every week. Also, feed conversion ratio (FCR) was determined for relevant time periods. Pens were tested twice daily (8 a.m. and 8 p.m.) for dead birds and the total mortalities were calculated as a percentage of live birds at the start of each treatment according to El-Husseiny et al. (2000). Blood samples (5 ml) were aspirated weekly from wing vein by disposable needle and transferred to heparinized vacuum tubes without delay to assess some blood parameters as Heterophyil/Lymphocyte (H/L) ratiousing May-Grunwald, Giemsa stains (Evrim et al., 2017) and Newcastle Disease Virus (NDV) antibody responses by the Haemagglutination Inhibition (HI) test At 28 days old only as, the peak of antibodies was achieved after 10-11 days from the second time of vaccination (Xie et al., 2008).

Behaviour observation and welfare indicator

The bird behaviour was recorded using a fixed digital camera over the experimental pens. The scan sampling technique from an electronic compact discwas used to monitor the bird behaviour (Bowden et al., 2008). For documenting the different behavior trends, each group was monitored three days a week (twice a day; each of 30 minutes) for for the duration of the entire experimental period at 7 am and 4 pm for reporting the different behavioural patterns. Individual birds (small pen) involved in feeding (at feeder), drinking (under the drinker), resting, pecking of feather, preening, stretching of wing and legs and wing flapping were counted at every 10 minutes of the observation period. Resting and sleeping, was listed as a rest behaviour (Rierson,2011). The welfare indicator was assessed using an internationally accepted score system used by Kestin et al. (1992) for the presence of foot pad dermatitis (FPD), hock burning damage (HBD), and bumble foot (BF). Both HBD and BF were graded on a three point scale (1, signs of deterioration without redness; 2, signs of deterioration with the presence of redness; and 3, an evident lesion or score). In addition, FPD was scored on a two point scale where 1 describing normal footpads without lesions, whereas a score of 2 was given for obvious sores on the footpads (Ekstrand and Carpenter, 1998).

Statistical Analysis

Data were reported as means ± SEM and analyzed by one-way ANOVA using Graph Pad prism 5. The significance of difference among the different groups was evaluated by Tukey's post hoc multiple comparison test. The significance level was set at $P < 0.05$.

RESULTS

Data in table (1) reflects the mean output values of broiler performance that were held under various intensities of blue light colour. Results showed that, the BWG at 35 days of age was higher in the birds kept under DBLI group (2052.15±2.028 g) compared to those kept under MBLI group (1890.22±3.786 g) and under HBLI (1897.83±1.764 g).

Regarding the feed intake and mortality percent, table (1) reveals that the overall consumption of feed intake did not vary in different treatments for blue light intensities (5 lux: 3662.1±0.624 g, 20 lux: 3657.1±0.328 g and 320 lux: 3658.8±0.290 g). The most economic FCR was recorded in birds kept under DBLI group (1.785±0.057) compared to those kept under MBLI group (1.934±0.088) and underHBLI (1.927±0.115). However, the lowest percentage of mortality was reported in broilers held under DBLI group then MBLI group (4.5 and 8.1%, respectively) compared to 10.8% for HBLI

Light intensity had a significant effect ($P<0.05$) on most broiler behaviours. Birds reared at low light intensity (5lux) displayed the lowest frequencies of feeding, drinking, wing flapping, and feather picking behaviours (Table 2).

Concerning leg problems, data in table (3) shows that the prevalence of FPD and HBD was significantly($P<0.05$) differed by different light intensities. Whereas, FPD and HBD were more common in broilers kept at 5 lux compared to broilers kept at 20 and 320 lux.

Moreover, birds reared at low light intensity environment (5 lux) had the lowest H/L ratio (0.43±0.006) compared to the other light intensity groups which had 20 lux; 0.58±0.006 and 320 lux; 0.63±0.004 as shown in table (4). Also, table 4 reveals that the highest concentration of total NDV antibody titer was recorded in high stocked broilers kept under dim blue light in this experimentin comparison with other treatments.

Table 1: Means ± SE of IR broiler performance under different blue light color intensities.

	HBLI	**MBLI**	**DBLI**	**P-Value**
IBW (g)	44.00±2.309	44.00±1.155	44.00±1.165	0.4219
7 day (g)	145.01±1.480	146.00±2.140	144.91±1.680	0.6217
35 day (g)	2042.84±1.501	2036.22±1.057	2197.06±9.970	0.0158
BWG (g)	1897.83±1.764	1890.22±3.786	2052.15±2.028	0.0442
TFI (g)	3658.8±0.290	3657.1±0.328	3662.1±0.624	0.5312
FCR	1.927±0.115	1.934±0.088	1.785±0.057	0.0390
WI (ml)	871.63±1.379	841.29±2.901	953.81±5.604	0.0114
M %	10.8	8.1	4.5	0.0421

HBLI: high blue light intensity; MBLI: moderate blue light intensity; DBLI: dim blue light intensity; IBW: Initial body weight; BWG: Body weight gain; TFI: Total feed intake; FCR: Feed conversion rate; M%: Mortality percent; SE: Standard error.

Table 2: Means ± SE of some broilers behaviors (Frequencies) kept under different blue light color intensities.

Behavior	HBLI	MBLI	DBLI	P-Value
Resting	7.33±1.202	10.33±1.453	19.00±0.577	0.0009
Feeding	3.00±1.155	10.00±1.155	1.66±0.881	0.0032
Drinking	5.00±0.547	10.00±0.574	1.00±0.577	0.0001
Pecking	5.33±0.819	2.66±0.881	2.00±1.155	0.0316
Preening	3.00±0.574	2.00±1.155	8.00±1.155	0.0114
Wing and leg stretching	2.00±1.155	7.00±1.165	8.00±1.158	0.0217
Wing flapping	3.00±0.819	2.33±0.574	1.00±0.544	0.0219

HBLI: high blue light intensity; MBLI: moderate blue light intensity; DBLI: dim blue light intensity; SE: Standard error.

Table 3: Means ± SE of some broilers behaviors (Frequencies) kept under different blue light color intensities.

Leg problems	**HBLI**	**MBLI**	**DBLI**	**P-Value**
FPD (%)	1.8	6.3	9	0.0121
HB (%)	2.7	13.5	18	0.0354
BF (%)	0	0	0	0.6032

HBLI: high blue light intensity; MBLI: moderate blue light intensity; DBLI: dim blue light intensity; FPD: foot pad dermatitis; HB: hock burns; BF: bumble foot; SE: Standard error.

Table 4: Means ± SE of some blood parameters of broilers kept under different blue light color intensities

	HBLI	**MBLI**	**DBLI**	**P-Value**
NVD Titer	2.09±0.076	2.82±0.094	3.08±0.056	0.0308
H/L	0.63±0.004	0.58±0.006	0.43±0.006	0.0011

HBLI: high blue light intensity; MBLI: moderate blue light intensity; DBLI: dim blue light intensity; NVD: Newcastle Viral Disease antibody; H/L: Heterophyil/ Lymphocyte; SE: Standard error.

DISCUSSION

Poultry is more affected by light intensity, and by using the retina of the eye, they can distinguish-between light colours with varying degrees of sensitivity (Lewis and Morris, 2000). The improvement in the performance of high stocked broilers reared under DBLI group may be attributed to a calming effect of blue light and the positive effect of this light color on feed intake and feed utilization. These results are in line with the findings of Downs et al. (2006); Velo and Ceular (2017) who reported that bird's performance was enhanced by low light intensity. Davis et al. (1999) reported similar findings, that low light intensity increased the bird body weight, feed intake, feed conversion and weight gain.

Concerning the broilers feed intake,there was no significant difference in the overall consumption of feed intake under different treatment for blue light intensities, these findings are supported by the findings of Rault et al. (2017) who noted that there was no significant difference in feed intake between broilers kept at 20 lux and 5 lux. But the obtained data are in disagreement with the results of Davis et al. (1999) who mentioned that the birds that were held under high light intensity ate and drank more than that those kept at the low light intensity. Also, Mosa et al. (2015) explained that blue light has a calming effect on birds making them less active than in white light and the bird preferes to spend more time in resting under blue light with a filled crop and gizzard content.I n addition, the best FCR was recorded inbirds reared under dim blue light. A possible explanation for why broilers prefer to consume more feed under white light due to it helps them to identify texture differences which they cannot see under other colors.

Adopting a strategy allowing broiler chicks to feed under white light and rest under blue light (Abu-Tabeekh et al., 2015).

These results are consistent with the findings of Downs et al. (2006) who stated that the lower light intensities may improve FCR due to reduced activity and stimulated muscle growth.

Furthermore, these results are partly supported by the findings of Buyse et al. (1996) who tested for FCR under 5 *vs*. 51 lux and Lien et al. (2008) who tested for FCR under 1.75 *vs*. 162 lux and they summarized that the decrease in LI had a significant improvement effect on FCR.

The highest mortality percent was reported in birds group held under HBLI group. Such findings are recorded by Newberry et al. (1988) and Buyse et al. (1996) who foundt hat the mortality rate increased with the increasing in the light intensity. But, Evrim et al.(2017) found that light intensity did not have any major impact on the mortality percent.

Behavioural studies are of great significance for enhancing animal cognition and understanding.

Light may be the most critical for chickens as it controls many behavioral patterns (Olanrewaju et al., 2006). Poultry producers are concerned with raising poultry in improved and comfortable conditions (Harper and Henson, 2001). The mean values of broiler behaviors were affected by different light intensities. These findings are in agreement with the results of Khalil et al. (2016) who observed thatdim light reduced eating and drinking behaviour. But, it is contrary to the findings of Newberry et al. (1988) who claimed that the light intensity had no effect on the behaviour of eating and drinking. In addition, in the current study the frequency of preening, rest, as well as leg and wing stretching was higher in birds kept under low light intensity than those kept under high light intensity. The rest behaviour is essential for poultry as it allows for energy preservation, tissue restoration and growth (Blokhuis,1984). These results are compatible with the findings of O'connor et al., (2011) who observed that the highest frequency of preening, dust bathing, leg and wing stretching, and body shaking was recorded in birds held under low light intensity (5 lux) when compared with the other groups (50 and 250 lux). This can be attributed to the birds kept under low light intensity in this investigation having been less involved with other aggressive activities and appearing to be less scared at low intensity (Davis et al., 1999).

If the bird held under high light intensity, it showed higher activity which needed high energy and therefore triggered the aggressive behavior (Newberry et al., 1988). So, low light intensity embraces to relegate cannibalism, aggression and pecking behaviour (Blatchford et al., 2009).

Sejian et al. (2011) described the animal welfare by the ability of an animal to adapt with its environmental stimuli either physiologically or behaviorally. The highest leg problems (FPD and HBD) were reported in broilers kept at 5 lux. This may be attributed to the lower activity of broilers kept under low intensity (5 lux), because the foot and hock burns are generally correlated with a reluctance to walk (McKeegan, 2010). Similar results were recorded byDeep et al. (2010) who reported that the prevalence of FPD was decreased by the increasing of light intensity from 1 to 40 lux. On the other hand, BF wasn't observed in all groups.

The H/L ratio is a sensitive stress indicator, because the H/L ratios in birds subjected to environmental stressors have increased (Evrim et al., 2017). The lowest H/L ratio and highest concentration of total NDV antibody titer were recorded in broilers kept underlow light intensity environment (5 lux). These findings were contrary to Evrim et al. (2017) who reported that light intensity had no impact on H/L ratios. These results proved that broiler chickens were more sensitive to light intensity. Whereas, when boilers reared at low light intensity environment, they had a low level of stress and strong light is considered a stress factor in poultry production (Guo et al., 2018). Increased percentage of NDV antibody titer under dim blue light in this experiment suggested that low light intensity improved the cellular and humoral immune responses of broilers. This could be explained by increasing melatonin secretion (Abbas et al., 2007), or by activating the peripheral T and B lymphocyte proliferation to produce antibodies (Abbas et al., 2008). The opposite results were obtained by Olanrewaju et al. (2016) who found no difference in immune parameters in broilers reared under different light intensities. Light intensity is routinely kept lowin the broiler production sector (usually 5 lux) to minimize bird activity to save energy (Prescott et al. 2003). But, commercially, there is an insight that very low light intensities improved feed efficiency and decreased carcass damage by the reduction of activity (Downs et al., 2006).

CONCLUSION

Dim blue color was a good atmosphere for keeping IR broilers less active, safe and increased their performance. In addition, dim blue light not only improved the performance, but also improved the ability to anti-stress as well as immune function. On the other hand, high intensity of blue light deemed to be detrimental to the birds welfare.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflict of interest.

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