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Original Article

Effects of Color Lights on Performance, Immune Response and Hematological Indices of Broilers

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ABSTRACT

Many studies have been shown the effects of light wave length on broilers performance in experimental assay, but we decided to evaluate the effects of different color lights on broiler performance, immune response and hematological parameters in filed study. For this purpose, 40000 day-old broiler chickens were placed in four houses as follow: green, sunny yellow, blue and red light. All light sources were equalized at the intensity of 25 lux, with light period of 23 hours daily. In days 8, 18, 30 and 42 from each house, 25 samples of serum were obtained to evaluate the ND-antibody responses. At 42 days of age, 25 blood samples were taken from each house to evaluate HDL, LDL, VLDL, triglyceride, cholesterol, total protein, creatinine, BUN and glucose of serum. The live body weight and feed intake were recorded weekly and Feed Conversion Ratio (FCR) was calculated. The results indicated that the birds reared under yellow and blue light had the best and weakest performance, respectively. The decrease of maternal antibody in group which reared under green light was the slowest and at the end of experiment the birds which were exposed to green and blue light had the highest ND antibody titers among all groups but it was insignificant ($P>0.05$). The birds in yellow light house showed a significant increase in total serum protein ($P<0.05$) and the birds in blue light house showed an insignificant reduction in serum triglyceride, glucose and BUN concentrations ($P>0.05$).

Keywords: Light Color, Performance, Immune Response, Hematological Indices, Broiler.

INTRODUCTION

Increasing competition and energy cost in poultry industry are mainsprings for broiler producers to find ways to minimize the cost of growth. The effect of light on poultry is a topic that has been studied for last 3 decades. Light is an important exogenous factor in broilers production which composed of at least three aspects including wavelength, intensity and photoperiod length. Affection of light on activity and reproduction of chickens had been known from many years ago and it was also shown by many researchers (Phillips, 1922; Newberry *et al*., 1988 and Blatchford *et al*., 2009). A few studies have explored on color light preferences of broiler chicks. Taylor *et al*. (1969) observed that one day-old chicks prefer red and yellow lights in comparison with blue light. Heshmatollah (2007) reported when chickens had the ability to choose among red, orange, yellow, or green lights, they spent significantly more time under green light. Their second preference was yellow light. Rierson (2011) concluded that chicks have a preference for white or red lights in comparison with blue and green lights. It is important to understand the effect of lights on the behavior of broilers as it can directly lead to changes in bird performance. Prayitno *et al*. (1997) conducted a study to compare broilers behavior under red, white, blue, or green lights. It was concluded that broilers raised under red and white lights were more active than those raised under blue and green lights. Numerous studies have been conducted on effects of wavelength (or color) on broilers performance but a field study on the affection of wavelength on broilers performance was scanty and the present study is undertaken to evaluate the effects of red, blue, yellow and green lights on broilers body weight gain, FCR, antibody response and some hematological parameters.

MATERIAL AND METHODS

This study was performed in a field condition. A farm which had four houses was chosen. The treatment

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houses were as follow: 1) exposed to green light, 2) exposed to sunny yellow light 3) exposed to blue light 4) exposed to red light. The lighting treatments were 23 hours of light per day. All birds were exposed with 25 lux (2.5 foot candles) light intensity for all period of the experiment and adjusted so that all were equal. This intensity was chosen because it's about the highest recommended intensity (25 lux) for broilers in ROSS 308 management-guide. Light intensity was measured as bird height at the middle of two bulbs within each house. The light sources were fluorescent bulbs. 40000 day-old Ross 308 broiler chicks of mixed sex were randomly placed in houses (10000 birds/house). During the study feed and water were provided on *ad libitum* basis and room temperature followed as recommended in management guide. Deep litter system with wood shaving floor was used. Strict sanitation practices were maintained in the house before and during the course of experiment. All birds were fed a standard commercial diet based on corn and soybean meal (table 1). Vaccination program was according to the local program and Newcastle Disease (ND) vaccines were B1, Clone30 and LaSota at days 9, 19 and 28, respectively. The live body weight of 120 birds of each house at 1, 7, 14, 21, 28, 35 and 42 days of age were taken and feed intake (hen/day) was recorded. Their FCR was calculated.

Blood samples from 25 birds at 8, 18, 30 and 42 days of age were collected for subjecting their sera to Haemagglutination Inhibition (HI) tests to determine the antibody response titers of ND vaccines. At the first day, we obtained 1mL blood from each 25 birds to computing the day of ND vaccination. Blood samples at 42 days of age were collected (30 birds/house) to determine some of the serum factors High Density Lipoprotein (HDL), Low Density Lipoprotein (LDL), Very-Low Density Lipoprotein (VLDL), triglyceride, cholesterol, total protein, creatinine, glucose, Blood Urea Nitrogen (BUN), calcium and phosphor.

The data were analyzed using computerized statistical program (ONE Way ANOVA) with its subsequent post hoc LSD tests (version 11.5, SPSS Inc., Chicago, IL, 2001) to determine the Mean ±SD of antibody titer, serum factors and body weight. A P-value of < 0.05 was considered significant.

Table 1. The experimental basal diets composition and calculated proximate analysis

Diet composition	Starter (0-10d)	Grower (11-28d)	Finisher (29-42d)
Corn	545	570	590
Soybean meal	395	361.5	334
Soybean oil	15	22.5	34
Calcium carbonate	12	13	12
DCP	17.5	17	15.5
Mineral premix	2.5	2.5	2.5
Vitamin premix	2.5	2.5	2.5
Salt	3.5	3.5	3.5
DL-methionine	2	2	1.6
L-lysine	1.3	1.8	0.8
Vitamin A	0.5	0.5	0.5
Vitamin B	0.5	0.5	0.5
Vitamin D	0.5	0.5	0.5
Vitamin E	0.7	0.7	0.6
Vitamin K_3	0.5	0.5	0.5
Coccidiostat	0.5	0.5	0.5
Enzyme	0.5	0.5	0.5

RESULTS

The effect of various color lights on chicken's body weight gain, FCR and mortality are presented in Table 2. The results showed that birds exposed to sunny yellow light had the highest weight gain at the end of experiment and was statistically significant (P<0.05). At the end of the study, FCR of birds elevated under red and yellow lights were lower than blue and green lights and it was significantly different in comparison with blue light (P<0.05). The birds that were reared under blue light at the end of the study had the lowest body weight and highest FCR (2190 g and 1.9, respectively). Total mortality at the end of experiment of blue and green groups was the highest (5.8%) and lowest (4.7%), respectively.

Table 2. The effects of various color lights on body weight gain, FCR and mortality of broiler chickens (mean±SD)

Items	Day 7	Day 14	Day 21	Day 28	Day 35	Day 42	FCR	Mortality (%)
Green	140±12^{a}	450±20^{a}	660±28^{a}	1050±40^{a}	1780±60^{a}	2240±100^{a}	1.84^{ab}	4.7
Blue	130±10^{a}	435±26^{a}	630±33^{a}	1010±46^{b}	1760±75^{a}	2190±80^{a}	1.90^{b}	5.8
Red	140±10^{a}	450±18^{a}	670±27^{a}	1040±38^{ab}	1790±68^{a}	2230±85^{a}	1.82^{a}	5.4
Yellow	155±15^{a}	460±25^{a}	680±20^{a}	1070±42^{a}	1830±70^{b}	2290±95^{b}	1.81^{a}	5.3

^{a,b} Means in the same column with different superscripts differ significantly (P<0.05).

The effects of treatment groups on antibody response to ND vaccine are shown in Table 3. The results showed that the birds which were raised under red and yellow lights had slightly lower titer but the difference among groups weren't significant at day 42 (P>0.05). One day before second vaccination, the antibody titers of red group were the lowest among groups and it was statistically significant in compare with green group (P<0.05). The results of hematological parameters in treatment houses of the experiment are presenting in Table 4 and 5. Birds which were exposed to yellow light had the highest total protein and it was statistically significant (P<0.05) in comparison with blue and red light. The serum triglyceride, glucose and BUN concentrations were insignificantly reduced by blue light (P>0.05) and the

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serum phosphor was significantly higher in birds under blue light ($P<0.05$). Treatment light bulbs did not statistically influence the serum calcium, cholesterol, HDL, LDL, VLDL and creatinine levels.

Table 3. The effects of various color lights on antibody response to ND vaccine of broiler chickens (mean±SD)

Items	Day 8	Day 18	Day 30	Day 42
Green	3.2±0.2 [a]	1.82±0.3 [a]	3.10±0.1 [a]	4.12±0.3 [a]
Blue	3.4±0.2 [a]	1.70±0.2 [ab]	3.16±0.1 [a]	4.10±0.2 [a]
Red	3.4±0.1 [a]	1.66±0.1 [b]	3.00±0.3 [a]	3.96±0.5 [a]
Yellow	3.3±0.2 [a]	1.72±0.3 [ab]	3.08±0.2 [a]	3.98±0.4 [a]

[a,b] Means in the same column with different superscripts differ significantly ($P<0.05$).

Table 4. The effects of various color lights on total protein, creatinine, glucose, BUN, phosphor and calcium of broiler chickens at 42 days old (mean±SD)

Items	Total protein ($g\ dL^{-1}$)	Creatinine ($mg\ dL^{-1}$)	Glucose ($mg\ dL^{-1}$)	BUN ($mg\ dL^{-1}$)	Phosphor ($mg\ dL^{-1}$)	Calcium ($mg\ dL^{-1}$)
Green	5.26±0.13 [ab]	0.59±0.011 [a]	187.1±8 [a]	9.6±28 [a]	6.62±0.5 [a]	7.94±0.8 [a]
Blue	4.63±0.08 [a]	0.63±0.011 [a]	172.9±9 [a]	9.1±28 [a]	7.13±0.4 [a]	7.53±1.1 [a]
Red	4.89±0.1 [a]	0.82±0.015 [a]	175.2±7 [a]	9.9 [a]	6.89±0.7 [a]	8.76±0.7 [a]
Yellow	5.4±0.11 [b]	0.74±0.014 [a]	188.3±12 [a]	9.5±28 [a]	5.71±0.6 [b]	8.56±0.9 [a]

[a,b] Means in the same column with different superscripts differ significantly ($P<0.05$).

Table 5. The effects of various color lights on cholesterol, triglyceride, HDL, LDL and VLDL of broiler chickens (mean±SD)

Items	Cholesterol ($g\ dL^{-1}$)	Triglyceride ($g\ dL^{-1}$)	HDL ($mg\ dL^{-1}$)	LDL ($mg\ dL^{-1}$)	VLDL ($mg\ dL^{-1}$)
Green	145.1±10 [a]	92.9±5 [a]	27.6±3 [a]	99±5 [a]	18.64±2 [a]
Blue	138.3±7 [a]	86.3±8 [a]	28.2±2 [a]	102.5±7 [a]	19±4 [a]
Red	146.4±6 [a]	104.8±10 [a]	28±2 [a]	87.1±3 [a]	23.2±4 [a]
Yellow	146.9±6 [a]	95±7 [a]	25±2 [a]	100.8±7 [a]	17.3±3 [a]

[a,b] Means in the same column with different superscripts differ significantly ($P<0.05$).

DISCUSSION

Growth in broiler is affected by light wavelength. In this study birds which were exposed to yellow light had highest body weight at the end of the experiment and it was also previously shown yellow light had positive effect on broilers performance (Hakan and Ali, 2005). By contrast to our finding, it was shown broilers under blue or green lights become significantly heavier than those reared under red or white lights (Rozenboim *et al*., 2004) and some reseaschers had demonstrated that broilers reared under blue or green lights become heavier while FCR and mortality remain unaffected (Wabeck and Skoglund, 1974; Rozenboim *et al*., 1999). Green light accelerated muscle's growth and stimulated growth at early ages, may be due to increase satellite cell proliferation during the first days of age (Halevy *et al*., 1998; Cao *et al*., 2008), but blue light stimulated growth in older birds (Rozenboim *et al*., 1999; Rozenboim *et al*., 2004; Cao *et al*., 2008). Hakan and Ali (2005) reported that wavelength between 435 and 600 nm (blue, green and yellow) had positive and higher wavelength like orange and red had negative effects on broilers' performances. Some authors had found no statistical differences in body weight gain or FCR when comparing red, green, and white lights in broilers (Kondra,1961; Petersen and Espenshade,1971; Wathes *et al*., 1982; Phillips, 1992). Son and Ravindran (2009) reported light hadn't any effect on body weight and feed intake but the FCR of birds receiving the blue light were more ($P<0.05$) efficient than those receiving white and red lights and it was in contrast to our results where blue light had negative effect on FCR. It was shown that red light could reduce FCR of broiler chickens (Wabeck and Skoglund, 1974) and it was in accordance with our finding. Foss *et al.* (1972) researched the development of cockerels raising birds under blue, green, red, and infrared light and in complete darkness. No differences were found in feed consumption ratio, but roosters raised under green light had higher body weight gain. It should be noted that different experimental approaches are related to the factors such as age and breed of chickens, diet composition and environmental condition.

It has been well documented that light has effective impact on immune response (Moore and Siopes, 2000; Onbaşılar *et al*., 2007; Blatchford *et al.*, 2009) but the effect of light color on the immune response is poorly understood. Xie *et al.* (2008) conducted a study using Light-Emitting Diode (LED) lights of different color (blue, green, red, and white lamps) to explore the impacts on the immune response of broilers. It was found that broilers reared under white light had the highest peripheral blood T-lymphocyte proliferation response compared to blue, green, or red lights. However it was found that blue and green light helped promote greater antibody production and immune function, compared to red light. The results of the Xie *et al.* (2008) is in agreement with our results where birds exposed to green and blue lights had insignificant ($P>0.05$) higher NDV antibody.

It has been shown that lighting program could affect the serum composition (Onbaşılar *et al*., 2007) but a document that explored the effects of light wavelength on hematological parameters of chicken is scanty. Serum glucose, cholesterol and triglyceride levels are as indicators of stress and birds under stress condition have elevated these three serum parameters (Puvadolpirod and Thaxton, 2000). In the present study, birds under blue light had the lowest levels of serum glucose, cholesterol and triglyceride (P>0.05) that indicated this wavelength had calming effect on broilers. Prayitno *et al*. (1997) also demonstrated that green or blue light created a calming effect on birds.

In conclusion, despite that green light was effective in reducing total mortality, current study suggest that yellow light was beneficial to the growth performance status.

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