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EFFECT OF DIFFERENT LIGHT INTENSITIES ON GROWTH PERFORMANCE, SERUM BIOCHEMISTRY, AND BEHAVIOR OF BROILER CHICKENS

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Abstract

This study aimed to assess the different light intensities' effect on performance, serum biochemical variables, and behavior of broiler chickens. 1200 newly hatched broiler chicks were randomly assigned to 1 of 6 light intensity treatments in 24-floor pens of 4.2 m^2 per pen at 42 days. The treatments consisted of 5, 10, 20, and 30 lux as constant during the whole study and the subsequent changes of light intensity were 30-20-10 and 20-10-5 lux that was altered after each rearing period. The results showed that body weight gain, feed intake, and FCR were unaffected by the treatments at 11, 25, and 42 days and overall period of 0 to 42 days of age. The serum biochemical parameters did not alter by the treatments. When the behavioral expressions were assessed during the entire study, light of varying intensities affected time spent on sitting, standing and pecking activity. Spending less time in an inactive behavior (sitting plus standing) was observed under 30 lux, while spending more time in an active behavior (walking plus pecking) was observed under the 20-10-5 lux treated group. Thus, the results obtained from the study suggested that growth performance and serum biochemical constituents did not differ with variations of light intensity, but varying light intensities had executed minor effects on the behavior of broilers. It can also be concluded that constant light intensity of not more than 5 lux or subsequent changes in light intensity could be applied in broiler farms without any adverse effects.

Keywords: Behavior; Light intensity; Performance; Serum quality

Introduction

Light is an important aspect of the physiological environment for poultry. Light intensity is one of the critical factors that play a pivotal role in the regulation and control of production, reproduction, welfare, immunity level, and other physiological parameters of chicken (Sadrzadeh et al., 2011; Deep et al., 2010). Lighting effects on the performance and activity of poultry chickens are widely dependent on light intensity levels (Kristensen et al., 2006). Several studies reported that light intensity ranging from 1 to 150 lux did not affect growth, feed intake, and feed conversion of broilers (Olanrewaju et al., 2016; Blatchford et al. 2009). On the other hand, it has been found that housing broilers under low light intensity resulted in higher body weight, improved feed-to-gain ratio, and increased growth rate compared to broilers raised under high intensity, due to the reduction of activity that promotes better utilization of energy (Lien et al., 2008; Blatchford et al., 2012). In addition, Buyse et al. (1996) mentioned that light intensity has varying stimulatory effects on the physiology and behavior of broilers. Light duration, intensity, color and wavelengths have influenced broiler chickens' behavior and physiological responses (Kristensen et al., 2007; Prayitno et al., 1997).

Meanwhile, previous studies demonstrated that light has an effect on most of the blood physiological variables of broilers, growth, and stress hormone (Kuhn et al., 1996; Olanrewaju et al., 2012), whereas other studies mentioned that no effect of light on blood physiological parameters (Onbasilar et al., 2007). Most of the researchers have explored the constant light intensity effects in broiler chickens. However, very few studies have reflected the combined impact of constant or subsequent changes in light intensity on performance, behavior, and biochemistry parameters in the serum of broilers. Thus, the purpose of the present study was to investigate both the effect of constant and subsequent changes in light intensity on growth, serum biochemistry, and behavior of broilers.

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Materials and Methods

A total of 1200 day-one (Cobb 500) broiler chicks were purchased from a commercial hatchery. The chicks were randomly allocated into six treatments based on light intensity in 24-floor pens measuring 1.95 × 2.15 m each, in a total area of 4.2 m^2. Each treatment had 200 chicks in 4 replicates of 50 chicks each. Six light intensity treatments were as follows: 5, 10, 20, and 30 lux were constant throughout the study (0-42 d), and treatments 30-20-10 lux and 20-10-5 lux in which subsequently altered at the end of pre-starter (0-11 d), starter (12-25 d) and grower (26-42 d) period, respectively. The temperature was initially set in the experimental house at 33^oC on the first day to the seventh day of age and then gradually reduced by 3^oC in the third week, and fixed at 22^oC until the end of the experiment. Each pen was supplied with an extra-large round feeder and nipple drinkers to ensure *adlibitum* access to feed and water throughout the study. All birds were fed the same commercial pre-starter (22.50% CP and 3050 kcal/kg ME), starter (20.50% CP and 3100 kcal/kg ME), and grower (18.50% CP and 3200 kcal/kg ME) mash diet from day 0 to 11, 12 to 25 and 26 to 42, respectively. Growth performance parameters in terms of body weight, weight gain, feed intake, and feed conversion ratio were computed for 0 to 11, 12 to 25, 26 to 42, and 0 to 42 days of age.

At the end of the experimental period (42 days), blood samples were collected from the wing vein of eight broilers from each treatment. Immediately transfer into heparinized test tubes and centrifuged at 3000 rpm for 15 min at 4^oC. Serum samples were taken into Eppendorf tubes and stored at -20^oC until biochemical values analysis, including albumin (ALB), total cholesterol (TC), high-density lipoprotein (LDH), glucose (GLU), total protein (TP), triglycerides (TG), aspartate aminotransferase (AST) and alanine aminotransferase (ALT) concentration were measured using a commercial kit according to the manufacturer's instructions.

The behavior of broilers was recorded by placing closed-circuit television (CCTV) cameras in two pens for each treatment in the experimental house. Video was recorded for a 24-hour period at 10, 20 and 35 days of age at the pre-starter, starter, and grower period, respectively. The birds involve in sitting, standing, walking, and pecking behavior were recorded for 30 minutes from 11.00 to 11.30 am in every observation period (15 birds were randomly chosen from each replication for each behavioral trait), and data were averaged. The behavioral patterns have been categorized as the following: sitting, without performing other activities; standing, just standing, without performing other activities; walking, either walking or running; pecking, either floor or feather pecking. This study also grouped individual behaviors into two categories for analysis: active and inactive. The active behaviors were walking and pecking. Sitting and standing were considered inactive behavior.

Statistical analysis

Data were analyzed using the general linear model procedure of SAS software (SAS 9.1, 2009) for analysis of variance as a completely randomized design. Duncan's multiple range was used to determine the significance of the difference at $P < 0.05$.

Results and Discussion

No differences were observed in weight gain under different light-intensity treatments during the experimental period (Table 1). The results of the present study agree with the study of Guo et al. (2018) who found no differential effect of light intensity (1 to 80 lux) on broiler growth performance traits in different age periods and overall of the study. The results were also in accordance with those of Olanrewaju et al. (2016), who could not be observed any difference between 5 lux and 20 lux on broiler growth and production performances. In addition, several earlier reports have also indicated no effect of light intensity on the body weight of broilers (Lien et al., 2007; Blatchford et al., 2009; Deep et al., 2010; Denbow et al., 1990). While some other studies have appeared to show the transitory effect of light intensity on body weight. Downs et al. (2006) observed that broiler chickens reared under low intensity 2.7 lux gained more weight than high intensity 21.5 lux. Similarly, Ahmad et al. (2011) also found that broiler chickens' body weight and weight gain were greater in low-intensity groups than high-intensity groups when exposed to light intensity of 5 to 40 lux. However, the authors have narrated that increasing the range of light intensity may significantly affect the body weight due to the increase in movement activity. Another study reported that broilers' body weight was improved due to light intensities ranging from 5.4 to 6.45 lux, and body weight decreased when birds were kept under light intensities

ranging from 107.6 to 124.7 lux (Kristensen et al., 2006). These authors suggested that the body weight was increased could be due to the reduced activity of birds when they reared under lower light intensity.

Table 1. Effects of different light intensity on performance of broiler chickens.

Light intensity (Lux)	Weight gain (g)				Feed intake (g)				Feed conversion Ratio(FCR)			
	0-11 d	**12-25 d**	**26-42 d**	**0-42 d**	**0-11 d**	**12-25 d**	**26-42 d**	**0-42 d**	**0-11 d**	**12-25 d**	**26-42 d**	**0-42 d**
30	301.68	1040.64	1192.30	2534.62	335.24	1458.12	2168.39	3961.75	1.110	1.401	1.818	1.563
20	297.27	1053.83	1183.80	2534.91	333.94	1456.29	2152.50	3942.73	1.124	1.382	1.819	1.555
10	289.33	1033.65	1149.89	2472.86	330.04	1420.66	2079.87	3830.57	1.141	1.374	1.809	1.549
5	294.29	1038.66	1169.43	2502.38	333.26	1419.52	2076.80	3829.58	1.133	1.367	1.775	1.530
30-20-10	297.16	1040.18	1149.32	2486.66	338.77	1454.78	2076.37	3869.91	1.140	1.399	1.809	1.557
20-10-5	298.36	1042.72	1167.40	2508.48	339.32	1455.28	2067.34	3861.94	1.138	1.396	1.773	1.540
SEM	1.86	3.60	12.06	12.87	2.40	7.95	22.58	24.42	0.006	0.007	0.010	0.005
P-value	0.56	0.76	0.91	0.72	0.91	0.50	0.71	0.52	0.65	0.67	0.61	0.46

SEM, standard error of the mean.

The mean values of feed consumption and feed-to-gain ratio of broiler chickens kept under different light-intensity treatments showed non-significant differences (Table 1). Similar to the other studies, Olanrewaju et al. (2011) found no effect of light intensity of 0.2 to 25 lux on feed intake and feed conversion of broilers from 0 to 35 days of age. Feed consumption had not influenced when broilers were exposed to 5 to 40 lux, but the feed conversion ratio was improved in the 5 lux treated group compared to those raised under remaining light intensity levels (Ahmad et al., 2011). Lien et al. (2007) also reported that feed consumption and feed-to-gain ratio of broiler chickens from 8 to 49 days of age was unaffected by providing intensity of 1 to 11 lux. The results of the current study were also harmonized with several earlier pieces of research with respect to feed consumption and feed conversion ratio during the overall experimental period (Charles et al., 1992; Deep et al., 2010).

On the other hand, it has been observed that feed intake was significantly improved when birds were subjected to the dim light of 5 lux or 1 lux from 1 to 9 days or from 9 to 51 days, respectively, in comparison to the bright intensity of 162 lux (Lien et al., 2008). An increase in feed consumption was observed by 2.17% up to 50 d of age when birds were reared under subsequent changes in the light intensity group than that of constant light intensity 21.5 lux (Downs *et al*., 2006). Olanrewaju et al. (2011) observed that FCR was improved as intensities were decreased from 25 to 5 lux at 28 days of age. It has been narrated that lower intensities may improve feed conversion by reducing active and stimulating muscular growth (Newberry et al., 1986). However, in the current study, performance parameters were not influenced by light intensity treatments, which indicated no such effects of these light intensities on broiler performances. It possibly be due to the cause of similar feed consumption in all light-intensity treated groups and thereby resulting in a similar feed-to-gain ratio, and no differences were obtained in the body weight gain of broilers.

Generally, the stress response is estimated by blood parameters such as cholesterol, glucose, triglyceride, total protein, aspartate aminotransferase, and hormones related to stress factor (Bedanova et al., 2007). Researchers have reported that different lighting programs, intensities, and sources of light can reflect the avian physiology, behavior, and biochemical values of chickens (Vandenbert & Widowski, 2000; Olanrewaju et al., 2006; Mahmood et al., 2014). However, in the present study, the biochemical concentrations were not affected by light intensities in the blood serum

of broilers (Table 2), which indicated that exposure of these light intensities could not be induced any physiological stress or adverse effect on broilers. The results of the current study were corroborated with the study of Dereli Fiden et al. (2017) reported that blood biochemistry concentrations did not affect except the level of triglyceride between light intensity treatment when broilers subjected to constant intensity 20 lux from 1 to 42 d of age and subsequently changes in light intensity 5 lux, 2.5 lux, and 1.25 lux from 1 to 8 d, 9 to 15 d and 16 to 42 d of age, respectively. The authors observed that triglyceride level was higher in the changes light intensity group, it may be associated with a decreased intensity that was below 5 lux. As a stress parameter, increasing the triglyceride level is described as an indicator of stress condition (Odihambo Mumma et al., 2006). According to Onbasilar et al. (2007), who measured blood parameters to evaluate the effect of different lighting programs, the result indicated lighting program had no impact on glucose, triglyceride and cholesterol levels. Olanrewaju et al. (2013) also observed no effect of light-intensity groups on plasma glucose, total protein, and other concentrations.

Table 2. Effects of different light intensity on serum biochemical indices of broiler chickens.

Light intensity (lux)	ALB (g/dl)	TP (g/dl)	GLU (mg/dl)	TC (mg/dl)	HDL (mg/dl)	TG (mg/dl)	AST (mg/dl)	ALT (mg/dl)
30	1.70	3.98	299.71	186.70	110.12	69.67	267.18	3.00
20	1.76	4.07	322.57	198.05	121.03	69.33	307.26	3.64
10	1.78	4.11	313.97	211.69	121.86	71.63	308.80	3.55
5	1.74	4.00	306.17	209.34	113.53	56.35	237.69	4.06
30-20-10	1.78	4.03	323.21	219.09	124.98	60.87	237.19	2.94
20-10-5	1.72	3.88	296.47	199.97	113.89	64.81	270.27	4.17
SE	0.03	0.07	4.63	6.96	3.05	4.00	23.76	0.38
P-value	0.94	0.95	0.43	0.84	0.72	0.89	0.93	0.92

SEM, standard error of mean; within the same column with different superscripts denoting significant differences ($P < 0.05$); ALB, albumin; TP, total proteins; GLU, glucose; TC, total cholesterol; HDL, high density lipoproteins; TG, triglycerides; AST, aspartate aminotransferase and ALT, alanine aminotransferase.

Behavioral expression of broilers was also observed under different light intensities during the study period (0 to 42 days of age) are summarized in Table 3. Time spent on sitting, standing, and pecking were affected significantly among the treatments. Sitting time was higher and standing time was lower when birds were kept in changes the light intensity of 30-20-10 lux treatment group, and time spent on pecking was significantly higher when birds were subjected to changes in light intensity of 20-10-5 lux group. In addition, data showed significantly spent less time in an inactive behavior when birds subjected to the constant light intensity at 30 lux group while spent more time in an active behavior under changes in light intensity of 20-10-5 lux treated group. Olanrewaju et al. (2006) noted that broiler behavior, activity and physiology could be affected by varying light intensity. Lewis & Morris (2000) stated that different wavelengths of light produce different intensities which have also varying stimulatory effects on the retina and can result in behavioral changes. In this study, the expression of total active behavior was more in changes in light intensity groups. It was in partial agreement with the results of Simmons (1982), who noted that birds were more active when broilers were exposed to intermittent lighting during the lighting periods.

Conclusion

The results of the present study revealed that birds kept in constant light intensity or subsequent changes in light intensity ranging from 5 to 30 lux could not be induced any adverse effect on production performance and serum biochemical constituents whereas just had executed some minor impact on the behavior of broilers. Birds were more active in subsequent changes in light intensity groups. Therefore, it can be concluded that the constant light intensity of not more than 5 lux or subsequent changes in light intensity may be used in broiler production farms without any physiological stress effect and to minimize the power save.

Conflict of Interests

The authors declare that there is no conflict of interest.

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