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Suresh Kumar
Department of Livestock Production Management, COVS, GADVASU, Ludhiana, India

Ravi Kant Gupta
Department of Livestock Production Management, COVS, GADVASU, Ludhiana, India

Amit Sharma
Department of Livestock Production Management, COVS, GADVASU, Ludhiana, India

RS Sethi
Department of Animal Biotechnology, COVS, GADVASU, Ludhiana, India

Yashpal Singh
Department of Livestock Production Management, COVS, GADVASU, Ludhiana, India

Neeraj Kashyap
Department of Animal Genetics & Breeding, COVS, GADVASU, Ludhiana, India

Correspondence
Suresh Kumar
Department of Livestock Production Management, COVS, GADVASU, Ludhiana, India

A comparison of stress related biochemical changes in broilers reared under coloured light emitting diodes *Vis-À-Vis* incandescent supplemental lighting

Suresh Kumar, Ravi Kant Gupta, Amit Sharma, RS Sethi, Yashpal Singh and Neeraj Kashyap

Abstract
Present study was conducted to compare the biochemical parameters of broiler birds' in an open-sided house under supplemental lighting programme using light emitting diodes (LEDs) and incandescent light. For this purpose 240 straight run commercial ven cobb broiler chicks were procured and distributed in four different light treatment groups i.e. T_1; white (650nm), T_2; green (565nm), T_3; blue (430nm) light LED (3 Watt each) and incandescent light bulbs (60 Watt each) as control (Tc) in 12 pens (4x3 factorial design). At the day time, open-sided house was open from 10.00 AM to 04.00 PM and rest of the time sides of the house was covered with the black coloured tarpaulin sheet. Biochemical parameters (serum I_g, glucose, total protein, BUN, GP_X, SOD, catalase and lipid peroxidation) were estimated from randomly collected blood from 3 birds of each replicate of each treatment at 7th, 21st and 42nd day of experiment period. Blood biochemical evaluation indicated that the level of total immunoglobulin at 6th week was significantly ($p\leq 0.05$) higher in T_3 (2.27±0.12) and T_2 (2.52±0.09) LED light treatment, whereas, catalase (7.25±0.11) was significantly ($p\leq 0.05$) higher in control group as compared to LED treatment groups. Interleukin 1β were estimated using bioassay technology laboratory enzyme- linked immunosorbent assay (ELISA) kit and the value on 21st day of experiment period was highest in T_1 group (3104.68±149.27) and T_3 group (1970.42±227.02) differ significantly ($P<0.05$) over control group (Tc) (2824.89±249.69). Whereas, on 42nd day control group (Tc) was having highest value (4956.58±396.87) and T_2 (2635.40±449.51), T_3 group (1974.97±139.05) differ significantly ($P<0.05$) over control group (Tc). However, all other blood biochemical parameters were within normal physiological range and differ non-significantly. From the study, it can be concluded that birds under LED light treatment showed somewhat lower stress level while the other parameter remained as good as compared to incandescent light treatment as supplemental light.

Keywords: Blood biochemistry, Broiler birds, Incandescent bulb, LEDs, Supplemental light

Introduction
Worldwide, poultry birds are reared under different production systems ranging from extensive, to intensive and for this fast growing poultry industry particularly modern commercial broiler stains, 80% of which is commercialized required a lot of artificial environmental factors like temperature, humidity, air velocity, rate of air exchange, gases, light intensity, duration and colour of light plays a significant role in intensive poultry production system. Light, being a major environmental stimulus affects bird activity, performance and immunity leading to a series of biochemical changes in broiler birds [1, 2, 3, 4] is well documented. Earlier conducted experiments observed that Chicken (21d of age) rose under yellow and green light treatment had higher level of IgG than those of birds reared under the white light treatments [2] whereas [4] worked on effect of monochromatic light on immune response of broilers and reported that birds under blue light group showed a 44.0% reduction in the level of serum interleukin-1β as compared with that in the red light group at 49 days of age. Therefore, light management in broiler production involving aspects of light intensity, wavelength and energy efficiency can be effectively explored without affecting the performance of broiler chickens and thus, the present study was planned with following.

Objectives

1. To compare the stress related biochemical changes in broilers reared under coloured light emitting diodes *vis-à-vis* incandescent supplemental lighting.
2. Estimation of Interleukin 1β (IL-1β) in broilers reared under coloured light emitting diodes and incandescent supplemental lighting.

Materials and Methods

Present study was conducted on 240 commercial Vencobb broiler chicks procured from M/s Venkey's India (Ltd.) at the Poultry Research Farm of the Department of Livestock Production Management, Guru Angad Dev Veterinary and Animal Science University, Ludhiana (Latitude: 30°54' North and Longitude: 75°48' East).

Experiment details: The day old sexed chicks were randomly distributed to 4 treatment groups each having 3 replicates. The housing treatments were T_1; white (650nm), T_2; green (565nm), T_3; blue (430nm) light LED (3 Watt each) and incandescent light bulbs (60 Watt each) as control (Tc) in 12 pens (4x 3 factorial designs). At the day time, open-sided house was open from 10.00 AM to 4.00 PM and rest of the time sides of the house was covered with the black coloured tarpaulin sheet. Matching colour curtains were placed inside each pen of shed according to light treatment requirement and each pen was completely enclosed to make it light proof. Light intensity was measured by light intensity meter (Lutron®PLX-111 light meter with range 0-20,000 LUX) and maintained at 25 Lux in first week and then reduces successively @ 5 Lux per week by increasing the height of bulbs from the bird eye level. The entire experimental period was divided into 3 phases namely starter (0-2 weeks), grower (3-4 weeks) and finisher (5-6 weeks). The starter, grower and finisher rations were formulated containing 22, 20 and 18 % crude protein and 2896, 2932 and 2979 Kcal ME/Kg of feed, respectively. The feed and water was available ad-libitum to chicks.

Observations recorded: To assess the biochemical parameters nine birds (3 from each replicate) from each treatment were randomly picked up for blood sampling at 7th, 21st and 42nd day. Total protein, Glucose and Blood urea nitrogen was estimated using Siemens® autopak kit whereas, total immunoglobulin was estimated using method given by [5] and [6], activity of Catalase was determined according to the method described by [7], glutathione peroxidase was assayed by the method of [8], superoxide dismutase were measured by the method of [9], Lipid peroxidation as evidenced by the formation of thiobarbituric acid reactive substances (TBARS) were assayed by the method described by [10]. For the estimation of Interleukin 1β (IL-1β) nine birds (3 from each replicate) from each treatment were randomly picked up for blood sampling at 21st and 42nd day. Chicken interleukin 1β (IL-1β) was estimated using Bioassay technology laboratory® Enzyme- linked immunosorbent assay (ELISA) kit.

Data on various biochemical parameters and behavioural study in relation to different treatments were subjected to one way analysis of variance (ANOVA) utilizing GLM procedure of SAS (SAS® 9.3) software and the difference among various treatments were examined by tukey's test.

Results and Discussion

Biochemical evaluation: The Data on biochemical evaluation (Table 1) indicated that the level of total immunoglobulin at 6th week was significantly ($p \leq 0.05$) higher in T_3 (2.27±0.12) and T_2 (2.52±0.09) LED light treatment, improving the level of immunoglobulin's and imparts greater immunity in birds reared under coloured lights and our results were somewhat similar to those of [2] who showed that green and blue light increases intestinal intraepithelial lymphocytes, goblet cells and igA+ cells in the small intestine, which increases intestinal mucosal immunity in broiler chicks. [11] Reported that light colour influences prolactin level in hamster and that prolactin can have regulatory effect on immune function in animals [12] (Herman and O Dorsio, 1991) and birds [13]. However, on 42nd day Tc group has highest total protein (2.73±0.04) whereas T_3 group has lowest (2.60±0.15) and did not differ significantly ($p \leq 0.05$) among various treatment groups and the results were similar and in accordance with the results of [14] who found that there was no significant difference ($p \leq 0.05$) in total protein between green and blue LEDs light. On 42nd day T_2 group has highest glucose and blood urea nitrogen level (218.57±4.61, 19.47±1.67 respectively) whereas Tc group has lowest (197.42±5.02, 14.78±2.04 respectively) and did not differ significantly ($p \leq 0.05$) among different treatment groups. The results of present study were contradictory to the results obtained by [15] as they reported that blue and green light calm the chicken, reduces anxiety and reduces oxidative stress thereby decreasing blood pressure and serum glucose. Whereas, catalase was significantly ($p \leq 0.05$) higher in control group (7.25±0.11) as compare to LEDs groups in which Tc is entirely different as compared to T_3(5.95±0.45) group. High level of catalase indicates high rate of muscle and tissue catabolism in response to stress in chicks of control (Tc) group, thus lower level of catalase in birds reared under LEDs indicates lower stress level. However no significant ($p \leq 0.05$) difference were found in glutathione peroxidase, superoxide dismutase and lipid peroxidation.

Table 1: Effect of different treatment groups on biochemical parameters

Parameters	Treatment	Age in days		
		7	21	42
Total protein (g/dl)	T_C	1.63^{d}±0.01	1.74^{c}±0.08	2.60±0.15
	T_1	2.09^{bc}±0.00	2.34^{a}±0.07	2.74±0.10
	T_2	2.10^{abc}±0.00	2.34^{ab} ±0.03	2.61±0.07
	T_3	2.13^{ab}±0.00	2.12^{ab}±0.07	2.73±0.04
Glucose (mg/dl)	T_C	190.65^{b}±1.55	217.57^{abc}±4.16	197.42±5.02
	T_1	212.98^{a}±0.38	204.65^{c}±12.37	198.96±8.44
	T_2	213.94^{a}±0.55	244.10^{ab}±7.07	218.57±4.61
	T_3	191.89^{b}±0.59	244.69^{a}±6.69	208.06±13.20
BUN (mg/dl)	T_C	6.20^{bc}±1.10	7.42±1.47	14.78±2.04
	T_1	9.00^{ab}±0.10	14.55±3.24	15.57±3.80
	T_2	8.38^{abc}±0.01	10.11±1.81	19.47±1.67

	T_3	10.35^{a}±0.00	13.62±1.48	15.61±2.57
Total immunoglobulin (g/dl)	T_C	1.96±0.04	2.12±0.08	2.07^{bc}±0.04
	T_1	1.97±0.01	1.97±0.06	1.71^{c}±0.13
	T_2	2.03±0.00	1.96±0.04	2.52^{a}±0.09
	T_3	1.91±0.00	1.95±0.03	2.27^{ab}±0.12
Catalase, µmole H_2O_2 decomposed/mm/g Hb	T_C	7.22^{a}±0.01	7.25^{a}±0.03	7.25^{a}±0.11
	T_1	6.52^{b}±0.01	6.69^{abc}±0.08	7.09^{ab}±0.20
	T_2	7.21^{a}±0.00	7.16^{ab}±0.09	7.03^{ab}±0.15
	T_3	5.08^{c}±0.00	6.17^{c}±0.34	5.95^{c}±0.45
Glutathione peroxidase (u/g Hb)	T_C	0.86^{a}±0.02	0.81±0.03	0.80±0.06
	T_1	0.82^{ab}±0.01	0.83±0.01	0.81±0.05
	T_2	0.77^{abc}±0.01	076±0.07	0.76±0.07
	T_3	0.77^{bc}±0.01	0.89±0.04	0.74±0.04
Superoxide dismutase EU/mg H	T_C	7.75^{ab}±0.00	7.76±0.07	7.67±0.05
	T_1	7.52^{c}±0.01	7.61±0.13	7.59±0.06
	T_2	7.78^{a}±0.01	7.73±0.07	7.73±0.09
	T_3	7.74^{ab}±0.00	7.70±0.08	7.71±0.07
Lipid peroxidation nmol MDA produced / g Hb/hou	T_C	3.23±0.02	3.28±0.07	3.33±0.09
	T_1	3.18±0.01	3.36±0.11	3.50±0.11
	T_2	3.16±0.00	3.22±0.07	3.37±0.10
	T_3	3.18±0.00	3.22±0.08	3.25±0.07

Means with different superscripts in a column differ significantly (P<0.05)

Interleukin 1β estimation: The data on Interleukin 1β (IL-1β) (Table 2) indicated that IL-1β value on 3rd week was highest in T_1 group (3104.68±149.27) and T_3 group (1970.42±227.02) differ significantly (P<0.05) over control group (Tc) (2824.89±249.69). Whereas, on 6th week control group was having highest value (4956.58±396.87) and T_2 (2635.40±449.51), T_3 group (1974.97±139.05) differ significantly (P<0.05) over control group (Tc) thus increasing the level of immunity and lowering the stress level which ultimately, improves the overall growth performance of broiler birds reared under supplemental lighting programme using light emitting diodes (LEDs) over incandescent light (control) group. The results finding were similar in accordance with the results of [14, 16 and 4] who reported that birds under blue light group showed a 44.0% reduction in the level of serum interleukin-1β as compared with that in the red light group at 49days of age.

Table 2: Effect of different treatment groups on interleukin 1β (IL-1β)

Parameter	3rd week	6th week
T_c	2824.89^{ab}±249.69	4956.58^{a}±396.87
T_1	3104.68^{a}±149.27	3288.72^{ab}±628.55
T_2	2558.79^{abc}±145.76	2635.40^{b}±449.51
T_3	1970.42^{c}±227.02	1974.97^{b}±139.05

Means with different superscripts in a column differ significantly (P<0.05)

Ethical Permission: Permission to conduct experimental trial was granted by Institutional animal ethics committee vide letter no. GADVASU/2015/IAEC/27/013

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Conflict of Interest: The authors declare that there is no conflict of interest

Conclusions

From this study, it can be concluded that LED light bulbs can be effectively and significantly explored in the field of poultry as a better alternative light source than incandescent light bulbs in reducing the stress level, improving the immunity without affecting the overall performance of broiler chickens.

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