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Impact of blue and green monochromatic light in comparison to white LED on the stress reaction and mortality rate of broiler chickens

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Abstract
The present experiment was conducted to investigate the impact of blue and green monochromatic light in comparison to white LED on the stress reaction and mortality rate of broiler chickens. For a period of 42 days study two hundred forty day old Vencobb 400 straight run commercial broiler chicks were randomly divided into three groups with 2 replicates of 40 in each at the poultry unit of livestock farm complex, College of veterinary sciences and animal husbandry, A.N.D.U.A.T. Kumarganj, Ayodhya, (U.P). In first green-blue group (T_{GB}), the birds were kept on green LED light (GL) and blue LED light (BL) from 1-21days and 22-42 days, respectively. The broiler birds of Group T_W and T_C were kept in white and incandescent LED lights for 42 days, respectively. The findings revealed that the heterophil % differed significantly ($P<0.05$) at 6th week of age when broiler finished their light treatment duration (after shifting from green LED to blue LED at 4th week of age). The ratio of blood heterophil to lymphocyte was also significantly differed ($P<0.05$) at the 6th week of age. The H/L ratio was higher in T_C group (0.37±0.008) whereas, it was lowest in T_{GB} group (0.33±0.456) than T_W group (0.35±0.120) birds at 6th of age. This study indicated that birds were minimum stress level in T_{GB} group than other treatment groups. The mortality rate of broiler chicks was highest in T_W group (6.25%) and lowest in T_{GB} group (3.75%) than T_C group (5%) birds. The results of the present study concluded that, broiler birds under green-blue (1-21d in GL and 22-42d in BL) LED bulb treatment group had significantly ($p<0.05$) lower stress as drawn by a ratio of Heterophil: Lymphocyte, which was highest in incandescent bulb treatment groups followed by white LED groups.

Keywords: Monochromatic light, stress reaction, mortality rate, broiler chicken

Introduction
For the large section of poultry meat consumers, the comprehensive mechanization of the poultry segment has made the broiler meat available in the recent years. Now the broiler meat is far most globally famous animal food product due to its nutritional, sensory and economical properties. It has a high potential to generate foreign exchange earnings through export of poultry products to neighboring countries. The Poultry industry has emerged as the fastest growing segment of the livestock sector both globally as well as in India (Iisa Augustine and Ruchira Shukla, 2015) [6]. Broiler production is one of the most dynamic and fastest growing animal husbandry sub-sectors in India. The total poultry population has increased by 16.81% over in the recent census and the total poultry in the country is 851.81 million. However, in previous census 2012, it was 729.21 million in numbers (Livestock census, 2019) [14]. Due to increasing population growth, urbanization and rising income there is an increasing demand of animal protein source so that chicken meat has shown its fastest growth in last two decades.
Lighting is an important environmental cause in poultry production that is known to affect performance and behavior. Chickens are visually well equipped, and therefore light plays very important role in their wellbeing and productivity. Light is constituted of a wide spectrum of electromagnet (EM) waves. The visible part of the electromagnetic (EM) spectrum is relatively small and is formed of wavelengths from approximately 350 to 800 nm. The eyes of broilers seem to be more sensitive to the broader spectrum than humans and these can perceive ultraviolet and infrared as well.

Components of Light in Poultry Management
Artificial light can be described by distribution of light (photoperiod), colour (wave length)

and degree of brightness (intensity) for commercially housed broilers.

Photoperiod

Photoperiod points to the pattern of light and consists of duration of darkness (scotophase) and light (photophase) over a 24 h period. Typically, broilers are reared following 23L: 1D through their first seven days of life accompanied by variable day lengths for the rest of the grow-out period.

Wavelength

Wavelength influences the colour of light and is usually pointed to as the quality of light. Understanding about the result of wavelength on poultry productivity is not widespread but there is evidence that it can affect bird performance.

Light Intensity (Illuminance)

Brightness pointed as light intensity is marked as the amount of luminance flux dropping on a unit region of a cover and is calibrated in units of lux (lx), similar to lumens per meter square. Currently, a similar proposal for the maximum level of light intensity to be accepted after the initial brooding state is lacking. Many types of LED lights are currently reasonable commercially. The major advantages of these lights are high performance, long working life, water protection, a single peak of light wavelength, which is characterized by a small half band product, and availability in separate monochromatic wavelengths (Craford, 1985) [2]. Usually, in traditional lighting management, four kinds of lamps (metal halide, fluorescent, incandescent and high-pressure sodium) are used in poultry facilities for laying birds, breeder flocks and broilers by poultry farmers.

India is a power deficient country facing an energy shortage of 2.1 % or 24,077 million units (MUs) and a peak shortage of 2.6 % of 4,208 Mw in 2015-16 (Business Standard, June 2015) [4] whereas, according to India's top power sector planning body i.e. central electricity authority the expenditure has touched 914.41, 957 and 1010kilowatt-hour (kWh) in 2012-13, 2013-14 and 2014-15, respectively.

In India, so far some research work has been accompanied related to the effect of LEDs on the performance of broiler chickens and little research is available. Hence, the present experimental design was planned to study the impact of blue and green monochromatic light in comparison to white LED on the stress reaction and mortality rate of broiler chickens.

Materials and Methods

The aim of the present investigation was to examine the impact of blue and green monochromatic light in comparison to white LED on the stress reaction and mortality rate of broiler chickens. For a period of 42 days study, two hundred forty (240) day old Vencobb 400 straight run commercial broiler chicks were randomly divided into three groups with 2 replicates of 40 in each at the poultry unit of livestock farm complex, college of veterinary sciences and animal husbandry, A.N.D.U.A.T. Kumarganj, Ayodhya, (U.P). In first green-blue group (T_{GB}), the birds were kept on green LED light (GL) and blue LED light (BL) from 1-21days and 22-42 days, respectively. The broiler birds of Group T_W and T_C were kept in pens under white and incandescent LED lights for 42 days, respectively. For stress analysis the blood samples (0.5ml) were collected from wing vein at 3rd and 6th week of experiment from 18 randomly selected birds from each group. To access H: L ratio, 100 leucocytes were counted and was determined by dividing the counted heterophils numbers from lymphocytes numbers (Gross and Siegel, 1983) [3]. Mortality (if any) was maintained on daily basis. The cause of mortality and gross pathological lesions were assessed by conducting post-mortem examination for each broiler chick.

Statistical analysis

To assess the impact of blue and green monochromatic light in comparison to white LED on the stress reaction and mortality rate of broiler chickens, experimental data were subjected to analysis of variance (ANOVA), using IBM SPSS Statistics® (20) software [5]. The means were compared for statistical significance difference at 5% level by Duncan alpha comparison.

Results and Discussion

The results of blue and green monochromatic light as compare to white LED on the stress reaction and mortality rate of broiler chickens have been shown as below:

(A) Heterophils/Lymphocytes Ratio (H/L Ratio)

The lymphocyte (%) did not differ ($P<0.05$) within light treatments group at 3rd and 6th weeks of age (Table 1). The heterophil (%) differed significantly ($P<0.05$) at 6th week of age when broiler finished their light treatment duration (after shifting from green LED to blue LED at 4th week of age). The blood heterophil to lymphocyte ratio substantially differed ($P<0.05$) at the 6th week. The H/L ratio was higher in T_C group (0.37±0.008), whereas it was lowest in T_{GB} group (0.33±0.456) then T_W group (0.35±0.120) at 6th of age. The findings of present study were in accordance with the results of Xie *et al,* (2008 and 2011) [12, 13]; Lewis and Morris (1998) [7]. The colour of light can be considered a powerful managemental tool for mitigating several stressors in broiler chicks by modulating various behavioral, physiological, immunological pathways (Prayitno *et al.*, 1997) [10] and (Xie *et al.* 2008) [12]. Lights also have calming effect on broiler birds and have been suggested for reducing stress, decreasing fear, modulating the stress response.

Table 1: Heterophil:Lymphocyte of the Experimental Broiler Birds below Different Light Treatments

Parameters (%)	Weeks	Light Treatments		
		T_C	T_W	T_{GB}
Lymphocyte	3rd	63.5±0.456	66.0±0.234	66.5±1.008
	6th	70.5±0.008	71.0±1.22	68.0±0.123
Heterophil	3rd	25.5±0.008	22.5±0.988	24.5±0.568
	6th	26.0^a±0.117	24.5^b±0.113	22.5^c±0.647
H/L ratio	3rd	0.4±0.011	0.4±0.006	0.4±0.189
	6th	0.37^a±0.008	0.35^a±0.120	0.33^b±0.456

Means with different superscripts in a row differ significantly ($P<0.05$).

(B) Mortality Rate

There were % differences in mortality in the data depicted in Fig.1. The mortality among different treatment groups was different. The mortality rate of broiler chicks was highest in white LED group (T_W) that is 6.25% and lowest in T_{GB} group (3.75%) then in T_C group (5%) where, 80 birds were kept in each treatment groups. The present research findings are not in accordance with the results of Mendes *et al* (2013) [8], Olanrewaju *et al* (2016) [9], Rogers *et al* (2015) [11] and Assaf *et al* (2015) [1] who reported that the mortality in broilers was not affected by any treatment group.

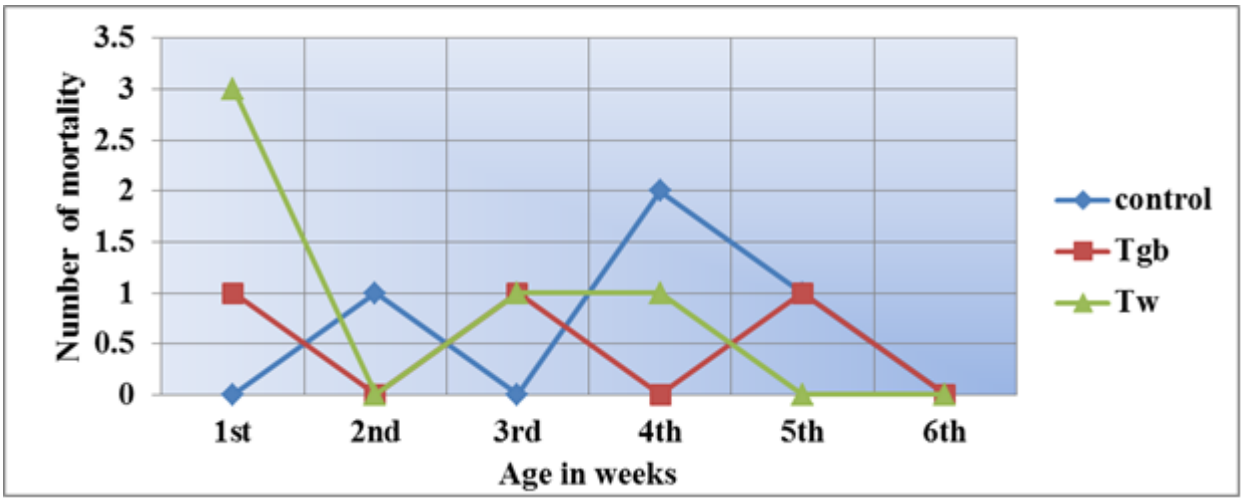

Fig. 1: Mortality up to 6th Week

Conclusion

The present investigation entitled "Impact of blue and green monochromatic light in comparison to white LED on the stress reaction and mortality rate of broiler chickens" was evident that the H/L ratio was higher in T_C group (0.37±0.008), whereas it was lowest in T_{GB} group (0.33±0.456) then T_W group (0.35±0.120) at 6th of age. This study indicated that birds were minimum stress level in T_{GB} group than other treatment groups. Whereas mortality rate of broiler chicks was highest in white LED group (T_W) that is 6.25% and lowest in T_{GB} group (3.75%) then in T_C group (5%). On the basis of above facts it may be concluded that, broiler birds below Green-blue (1-21d in GL and 22-42d in BL) LED bulb treatment groups were having significantly ($p<0.05$) less stress as drawn by a ratio of Heterophil: Lymphocyte, which was the highest in incandescent bulbs treatment groups than white LED groups.

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