Effects of colour and intensity of artificial light produced by incandescent bulbs on the performance traits, thyroid hormones, and blood metabolites of broiler chickens

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ABSTRACT

Light is an important environmental factor in poultry farm management. Duration, intensity and colour of light (wavelength) can be affected the poultry performance. The aim of present research was to study the effect of colour and intensity of incandescent bulbs light on the performance traits, hormones, and blood metabolites of broiler chickens. For this, a factorial experiment was used in the form of a completely randomised design for 42 days. The factors were included the colour and intensity of light. The number of treatment and replication was 6 and 4, respectively. Ross 308 male broiler chicken was used. Performance traits, hormones, and blood metabolites were measured and analysed with the Lsmeans procedure by SAS software. The effect of studied factors was significant \( p < .05 \) on the body weight and feed conversion ratio (FCR) at all rearing periods. The best body weight and FCR were observed in the green light with the 50 lux intensity. The light colour effect was significant \( p < .05 \) on the haemoglobin and haematocrit levels. Reducing the blood haemoglobin concentration in red light relative to green light can be due to a decrease in metabolic activity, which leads to a decrease in erythropoiesis and subsequently decreases the oxygen-carrying capacity of blood. Considering the favourable effect of green light (5 and 50 lux) on performance traits, it is suitable for rearing the broiler chickens.

HIGHLIGHTS
- Light is an important environmental factor in the poultry farms.
- Green light of 50 Lux has desirable effects on the performance traits.
- The lowest concentration of haemoglobin and haematocrit is observed in red light.

Introduction

Light is an important and effective environmental factor in poultry farms. Understanding, management, and control of light can be effective in the performance of broiler chickens (Rozenboim et al. 1999; Olanrewaju et al. 2006; Lien et al. 2007). Light is a visible electromagnetic radiation. Light nature is depending on its wavelength. Different light wavelengths are leading to the colour sensation. The light characteristics that effect on the chicken’ biology are the light duration, light intensity, and light colour (Prayitno et al. 1997; Olanrewaju et al. 2006; Cao et al. 2012). The positioning of chicken’ eyes on both sides of the head is the cause of the low focus in binocular visions and wide monocular vision. There are two types of light-receiving cells in the retina. The first type is the rod cells. They are heavily sensitive to light and provide the ability to see in the poor light. The second type is the cone cells that are responsible for daylight vision. The number of rod cells is more than cone cells. Rod cells are active in the light intensity of less than 4 candle/m² and cannot distinguish the colours. However, cone cells are responsible for vision at higher brightness levels (4–44 candle/m²). There are three types of cone cells. Each cone cell is covered by special oil droplets that allow a certain wavelength of the light to penetrate into the cell (and reach the nerve fibre). Chicken’ eyes have another type of cone cell, with a maximum sensitivity of 415 nm. They can detect the radiations under 400 nm. Liquids and lens
of chicken’s eyes have a vision clarity in the wavelengths of 320 to 340 nm, which means that the chickens are able to see in the Ultraviolet-A (UV-A). Recognition the colour by the chicken’s eyes is different from the human’s eyes (Olanrewaju et al. 2006; Kim et al. 2013; Signor et al. 2013). The chicken is sensitive to some UV radiation frequencies, while the human is not. Also, the chicken is more sensitive to the blue and red parts of the spectrum. Lux is the measurement unit of light intensity. However, the lux is not a suitable and accurate unit for measuring the light intensity in the poultry farms, because in its calculation is used the spectral lighting efficiency of human (Olanrewaju et al. 2006). To measure the UV light, advanced equipment is needed that cannot be easily used in poultry farms. Furthermore, use of light cells is not economic for poultry farms. For this reason, light intensity in poultry farms is measured by lux unit.

Generally, four types of bulbs are using in the poultry farms which include incandescent, fluorescent, metal halide, and high-pressure sodium (Olanrewaju et al. 2006). In the poultry farms of the Middle East, such as Iran, the incandescent bulbs are used to provide the lighting. Some characteristics of the incandescent bulbs are the low initial cost, full-colour expression (i.e. the ability to reveal colours), and easy installation. However, the average lifespan of incandescent bulbs is short and ranges from 750 to 2000 hours (Olanrewaju et al. 2006). The primary light of the coloured incandescent bulb is white, but the output light is coloured. The reason is the presence of pigments on the glass filter that gives out other wavelengths. The output initial light from the incandescent bulb includes a continuous wave spectrum. Visible light is the favourite part of this wave spectrum. However, most of the energy is used to produce light near the infra-red wavelengths. Therefore, the frequency of light produced by these lamps and their effect on the performance of broiler chicks is different from the monochromatic light (Olanrewaju et al. 2006).

The light intensity affects the activity, rest and consumption of chickens. The high light intensity increases the movement and stress of chickens (Buyse et al. 1996; Olanrewaju et al. 2006; Xie et al. 2008; Kim et al. 2013). In the low light intensity, decreases the walking, quarrel, fighting, moulting and cannibalism (Hartin et al. 2002; Olanrewaju et al. 2006; Lien et al. 2007). The light colour is affected by its wavelength and has different effects on the performance of broiler chickens. The blue colour makes the chicken calm. The red colour reduces the feather pecking and cannibalism. The blue-green and orange-red colours stimulate the growth and reproduction, respectively (Prayitno et al. 1997; Olanrewaju et al. 2006; Senaratna et al. 2015; Khaliq et al. 2017). The green light accelerates muscle growth and stimulates growth at an early age. The blue light stimulates growth at older ages (Olanrewaju et al. 2006; Cao et al. 2008). The aim of the current study was to investigate the effect of colour and intensity of incandescent bulb light on the performance traits, hormones, and blood metabolites of Ross 308 broiler chickens.

Materials and methods

Experimental design, factors, and broiler birds

This research was carried out as a 3 × 2 factorial experiment in the form of a completely randomised design for 42 days. Factors were included the light colour in three levels of green, yellow and red, and the light intensity in two levels of 5 and 50 lux. Five lux is the minimum light intensity for the broiler chickens rearing (Yang et al. 2018). Each of the three light colours was paired with one of the two light intensity levels. The light-intensity level combinations were used for all pens. The number of treatment, replication, pen (experimental unit), and broiler birds per pen in the research were 6, 4, 24, and 15, respectively. Three hundred and sixty chickens of male Ross 308 were used in the experiment.

Characteristics of pens (experimental units)

Pens were designed to meet the suitable conditions for carry out the present study. For this purpose, the lighting of each pen was controlled. The only source of light was the incandescent bulb inside the pen. It was not possible to penetrate the light from outside into the pens. Each pen was equipped by closed-circuit television (CCTV) with night vision capability. By CCTV, the behaviour of chickens was observed. All pens were built on three floors. Each floor had eight pens. The width, length, and height of each pen were 1.0, 1.5, and 0.7 m, respectively. Each pen like a chicken farm was included a nipple drinker, a feeder, a ventilation device, and a separate lighting system. In the first week, the primary feeder (flat feeder) was used. The primary feeder was in the form of a round tray at a depth of 4 cm. The pan feeder was used from the beginning of the second week to the end of the experiment. The ventilation system was a fan with dimension was 29 × 29 cm. The litter of pens was the moving metal laces. So, washing and disinfecting of the laces were easy. Pens moisture was controlled,
Table 1. Characteristics of incandescent bulbs of the present research.

| Power (w) | Voltage (v) | Luminous flux (lm) | Energy consumption (kWh) | Energy label | Bulb length (mm) | Bulb diameter (mm) | Bulb type |
|-----------|-------------|--------------------|--------------------------|--------------|------------------|------------------|-----------|
| 40        | 230         | 400                | 40                       | E            | 103.5            | 60               | Simple    |

*w: Watt; v: Volt; lm: Lumen; kWh: Kilowatt-hour; mm: Millimetre.

continuously. Relative humidity was 65% in each pen at all experiment phases. Digital thermometers were used for the accurate temperature recording. The temperature of each pen was 32°C at the beginning of the rearing. Pens temperature was reduced gradually and reached 24°C at the end of the rearing. All pens were placed in a salon. The salon was equipped by the temperature and ventilation regulator. The conditions of humidity and the temperature of the salon were considered like pens. Ten days before the start of the research, preparation processes and disinfection of pens were carried out.

**System and programme of lighting**

An incandescent bulb connected to dimmer was used to provide the light in each pen. The dimmer was used to regulate the intensity of light. Light intensity was measured three times per day by lux-meter (LX1010b-MASTECH®-China). Bulbs were placed at a distance of 60 cm from the pen bottom. The lighting programme was performed during the experiment for 23 hours of light and one hour of darkness. Characteristics of the incandescent bulbs of the present study are presented in Table 1.

**Rations and rearing phases**

Chickens were fed with formulated ration based on the corn (8% CP), wheat (12% CP) and soybean meal (43% CP). Rations were prepared according to the national research council guidelines (NRC, 1994). As shown in Table 2, rations were formulated for three rearing phases that included the starter, grower, and finisher. The starter, grower and finisher rations were used in days of 1–14, 15–28 and 29–42, respectively. The feed of the starter, grower, and finisher were crumbles, one-millimetre pellets and three-millimetre pellets, respectively. In all pens, chickens had free access to water and feed.

**Studied traits**

**Performance traits**

Feed intake and body weight were measured in each rearing phase by a digital scale with two grams’ accuracy. Then, feed conversion ratio (FCR) was calculated from the feed intake divide to body weight gain. No mortality was observed during the research.

**Blood metabolites, and thyroid hormones**

At the end of the experiment (day 42), two chickens were selected randomly from each pen and blood samples were collected through the wing from Jugular vein. Blood samples were transferred into the tubes with and without the anticoagulant EDTA (ethylene diamine tetra acetic acid) for measurement the thyroid hormones and blood metabolites, respectively. Then, tubes were placed in an ice flask and sent to the specialised laboratory, immediately. Triiodothyronine (T3), tetraiodothyronine (T4), and thyroid-stimulating hormone (TSH) were measured. Blood samples of tubes without and with the anticoagulant matter were centrifuged by the centrifugal machine
Table 3. Effect of the colour and light intensity on the feed intake in different phases (gr).

| Factors | Starter phase (1–14 day) | Grower phase (15–28 day) | Finisher phase (29–42 day) | Whole (1–42 day) |
|---------|--------------------------|--------------------------|---------------------------|------------------|
| Light colour |                           |                          |                           |                  |
| Green   | 359.67                   | 1901.67                  | 4072.83                   | 4676.00          |
| Yellow  | 371.50                   | 1865.92                  | 4167.67                   | 4774.30          |
| Red     | 365.75                   | 1825.17                  | 4138.83                   | 4768.5           |
| SEM     | 6.89                     | 27.86                    | 43.75                     | 84.21            |
| p Value | .09                      | .14                      | .10                       | .12              |
| Light intensity |                     |                          |                           |                  |
| 5 lux   | 364.44                   | 1846.39                  | 4165.94                   | 4780.00          |
| 50 lux  | 364.83                   | 1815.44                  | 4086.94                   | 4699.22          |
| SEM     | 5.63                     | 22.74                    | 38.66                     | 68.76            |
| p Value | .11                      | .13                      | .10                       | .13              |

Table 4. Effect of the colour and light intensity on the body weight in different phases (gr).

| Factors | Starter phase (1–14 day) | Grower phase (15–28 day) | Finisher phase (29–42 day) | Whole (1–42 day) |
|---------|--------------------------|--------------------------|---------------------------|------------------|
| Light colour |                           |                          |                           |                  |
| Green   | 378.33<sup>a</sup>       | 1420.25<sup>a</sup>      | 2737.08<sup>a</sup>       | 3077.00<sup>a</sup> |
| Yellow  | 355.58<sup>b</sup>       | 1367.34<sup>b</sup>      | 2601.42<sup>b</sup>       | 2858.00<sup>b</sup> |
| Red     | 358.00<sup>b</sup>       | 1333.96<sup>b</sup>      | 2555.25<sup>b</sup>       | 2661.67<sup>b</sup> |
| SEM     | 5.26                     | 13.88                    | 34.59                     | 31.86            |
| p Value | .00                      | .00                      | .00                       | .00              |
| Light intensity |                     |                          |                           |                  |
| 5 lux   | 355.89<sup>a</sup>       | 1349.91<sup>a</sup>      | 2616.94                   | 2923.22          |
| 50 lux  | 372.06<sup>a</sup>       | 1397.79<sup>a</sup>      | 2645.56                   | 2941.22          |
| SEM     | 4.29                     | 11.33                    | 28.24                     | 26.02            |
| p Value | .00                      | .00                      | .08                       | .09              |

SEM: Standard error of the mean.
Non common superscripts in each column indicate the significant statistical difference (\( p < .05 \)).

Results

Performance traits

Based on the results presented in Table 3, the effect of colour and light intensity and their interaction were not significant (\( p > .05 \)) on the feed intake in different phases of rearing.

Results of Table 4 were shown that the effect of colour and light intensity and their interaction were significant (\( p < .05 \)) on the body weight in all phases. In exception for the effect of light intensity that was not significant in the finisher phase and whole phase on the body weight (\( p > .05 \)).

According to the results of Table 5, the effect of colour and light intensity and their interaction were significant (\( p < .05 \)) on the FCR in all phases. However, the effect of light intensity was not significant (\( p > .05 \)) on the FCR in all phases. Minimum and maximum FCR was observed in the whole phase for the green and yellow light, respectively. Also, minimum and maximum FCR was observed in the whole phase for the light intensity of 5 and 50 lux, respectively.

Blood metabolites and thyroid hormones

Based on the results of Tables 6 and 7, it can be seen that the effect of colour, light intensity and their interaction were not significant (\( p > .05 \)) on the RBC, WBC, platelets, glucose, cholesterol, triglycerides, HDL, LDL, VLDL, T3, T4, TSH, calcium, and phosphorus levels. But, the effect of light colour was significant (\( p < .05 \)) on the haemoglobin and haematocrit concentration.
Maximum and minimum percentage of the haemoglobin and haematocrit concentration were observed in the yellow and red light, respectively.

**Observations by CCTV**

Using CCTV in each pen, the behaviour of chicks and their reactions to light was observed. In chickens under green light was observed the activity reduction, the fewer growth of feathers, body weight gain, and FCR improvement. The chickens were calm in green light, and do not had the stress. Food intake in yellow light was more than other lights.

**Discussion**

**Performance traits**

The body weight of chickens in rearing pens with green light was more than the body weight of chickens in the rearing pens with the yellow and red light. Thyroid hormones are responsible for controlling the body metabolism and weight. The salon light of rearing by the secretion stimulation of thyroid and testosterone hormones is the cause of the body weight gain of broiler chickens. The green light reduces the body metabolism with effect on thyroid hormones and subsequently increases the body weight. In addition to the above, the green light is accelerating the muscle growth and stimulate growth at an early age (Olanrewaju et al. 2006). The present study findings are in agreement with published reports in this field (Olanrewaju et al. 2006; Cao et al. 2008, 2012; Senaratna et al. 2015).

**Table 5. Effect of the colour and light intensity on the FCR in different phases.**

| Factors                  | Starter phase (1–14 day) | Grower phase (15–28 day) | Finisher phase (29–42 day) | Whole (1–42 day) |
|--------------------------|--------------------------|--------------------------|-----------------------------|------------------|
| **Light colour**         |                          |                          |                             |                  |
| Green                    | 0.91 b                   | 1.26 b                   | 1.48 b                      | 1.52 b           |
| Yellow                   | 0.99 a                   | 1.35 a                   | 1.59 a                      | 1.67 a           |
| Red                      | 0.98 a                   | 1.35 a                   | 1.61 a                      | 1.66 a           |
| SEM                      | 0.02                     | 0.02                     | 0.02                        | 0.03             |
| **p Value**              | .04                      | .03                      | .03                         | .03              |
| **Light intensity**      |                          |                          |                             |                  |
| 5 lux                    | 0.98 b                   | 1.35 a                   | 1.58 a                      | 1.63             |
| 50 lux                   | 0.94 a                   | 1.29 a                   | 1.54 b                      | 1.61             |
| SEM                      | 0.02                     | 0.01                     | 0.01                        | 0.02             |
| **p Value**              | .04                      | .03                      | .04                         | .05              |
| **Colour × intensity**   |                          |                          |                             |                  |
| Green × 5 lux            | 0.93 ab                  | 1.31 b                   | 1.54 a                      | 1.56 bc          |
| Green × 50 lux           | 0.89 b                   | 1.20 b                   | 1.42 b                      | 1.48 b           |
| Yellow × 5 lux           | 0.99 a                   | 1.35 a                   | 1.60 a                      | 1.66             |
| Yellow × 50 lux          | 0.99 a                   | 1.36 a                   | 1.57 a                      | 1.67 a           |
| Red × 5 lux              | 1.02 a                   | 1.40 a                   | 1.61 a                      | 1.67 a           |
| Red × 50 lux             | 0.93 ab                  | 1.31 b                   | 1.61 a                      | 1.65 ab          |
| SEM                      | 0.03                     | 0.02                     | 0.02                        | 0.03             |
| **p Value**              | .03                      | .03                      | .02                         | .02              |

FCR: feed conversion ratio; SEM: Standard error of the mean.
Non common superscripts in each column indicate the significant statistical difference (p < .05).

**Table 6. Effect of the colour and light intensity on the blood metabolites – part 1.**

| Factors                  | WBCA (× 10^6/μl)² | RBCC (× 10^6/μl)² | Haemoglobin (mg/100ml)² | Haematocrit (%) | Platelet (mg/100ml)² | Glucose (mg/100ml)² | Cholesterol (mg/100ml)² | Triglyceride (mg/100ml)² |
|--------------------------|-------------------|------------------|------------------------|-----------------|----------------------|---------------------|-----------------------|------------------------|
| **Light colour**         |                    |                  |                        |                 |                      |                     |                       |                        |
| Green                    | 18.28 2.60         | 9.98 a           | 35.02 a                | 13.56           | 189.19               | 149.25              | 99.34                 |                        |
| Yellow                   | 18.38 2.56         | 10.04 a          | 35.73 a                | 13.70           | 191.23               | 148.33              | 97.56                 |                        |
| Red                      | 18.40 2.62         | 8.80 b           | 31.70 b                | 13.65           | 189.79               | 150.58              | 98.49                 |                        |
| SEM                      | 0.89 0.12          | 0.42             | 1.09                   | 0.23            | 9.78                 | 10.26               | 6.71                  |                        |
| **p Value**              | .10 .09            | .02              | .02                    | .09             | .08                  | .07                 | .07                   |                        |
| **Light intensity**      |                    |                  |                        |                 |                      |                     |                       |                        |
| 5 lux                    | 18.41 2.58         | 9.43             | 34.61                  | 13.57           | 190.46               | 148.13              | 98.13                 |                        |
| 50 lux                   | 18.45 2.61         | 9.69             | 35.06                  | 13.68           | 193.10               | 150.73              | 97.85                 |                        |
| SEM                      | 0.58 0.09          | 0.29             | 0.95                   | 0.18            | 7.47                 | 8.75                | 4.85                  |                        |
| **p Value**              | .07 .08            | .07              | .06                    | .09             | .07                  | .07                 | .08                   |                        |
| **Colour × intensity**   |                    |                  |                        |                 |                      |                     |                       |                        |
| Green × 5 lux            | 18.39 2.62         | 9.73             | 34.85                  | 13.60           | 191.75               | 151.00              | 98.00                 |                        |
| Green × 50 lux           | 18.41 2.61         | 10.16            | 35.20                  | 13.62           | 192.00               | 149.55              | 96.50                 |                        |
| Yellow × 5 lux           | 18.43 2.59         | 9.94             | 34.95                  | 13.65           | 190.50               | 148.17              | 95.17                 |                        |
| Yellow × 50 lux          | 18.38 2.61         | 10.16            | 35.01                  | 13.67           | 190.08               | 148.50              | 97.00                 |                        |
| Red × 5 lux              | 18.40 2.60         | 9.86             | 34.98                  | 13.63           | 189.17               | 147.50              | 95.33                 |                        |
| Red × 50 lux             | 18.41 2.61         | 9.74             | 34.40                  | 13.64           | 190.00               | 149.67              | 97.33                 |                        |
| SEM                      | 1.02 0.14          | 0.59             | 1.90                   | 0.42            | 18.60                | 23.80               | 20.60                 |                        |
| **p Value**              | .09 .09            | .07              | .08                    | .09             | .08                  | .07                 | .06                   |                        |

SEM: Standard error of the mean.
²White blood cell.
²Red blood cell.
²Microliter.
²Milligram per 100 milliliters.
Non common superscripts in each column indicate the significant statistical difference (p < .05).
Amplification of the light intensity from 5 lux to 50 lux is causing the body weight gain. The interaction of colour and light intensity show that in each light colour, the body weight was increased with an increase in the light intensity. These findings are in agreement with many other earlier reports (Lien et al. 2007, 2008).

Feed conversion ratio (FCR) is calculating from the feed intake divide to body weight (Lien et al. 2008; Cao et al. 2012). Therefore, factors that affecting the body weight and feed intake will be affected on FCR. The best FCR (in all rearing phases) was calculated for chickens in green light pens. The interaction of colour and light intensity show that in each light colour, the FCR was decreased with an increase in the light intensity. The chicken’s visibility is poor in the low-frequency light such as green light. Therefore, the chicken is more relaxed in green light, and it has not the extra activity, and aggression (Olanrewaju et al. 2006; Senaratna et al. 2015). So, the significant percentage of the energy and nutrient of feed are used to grow muscles and increase the body weight, consequently, FCR is reduced. In the present study, with increasing the light intensity from 5 to 50 lux, FCR was reduced. Reducing FCR is means increasing the efficiency of the use of consumed feed by the chicken for the body weight. The chicken is stimulated for eating the feed by the light with the intensity of 50 lux. In general, FCR in coloured lights of 50 lux is better than 5 lux. On the other hand, the best FCR was observed in the green light of 50 lux (in the whole phase).

### Blood metabolites and thyroid hormones

In the present study, reducing the concentration of blood haemoglobin in red light relative to green light can be due to the decrease in metabolic activity. It is lead to a decrease in erythropoiesis and subsequently decreases the oxygen-carrying capacity of the blood. The light intensity did not affect the blood metabolites. The current study results are agreement with the published reports in this field (Olanrewaju et al. 2008, 2012). In a study using monochromatic light, the significant effect of light colour was observed on the platelet, haematocrit, and RBC (Kim et al. 2013). In the present study, haemoglobin and haematocrit concentration was affected by light colour. Changes in other blood metabolites and thyroid hormones were not significant. Published findings in this field confirm the present study results (Firouzi et al. 2014).

### Conclusions

In the Middle East (such as Iran), incandescent bulbs are commonly used to provide the lighting for broilers. Insufficient light in the chicken farms is insufficient. The interaction of colour and light intensity show that in each light colour, the body weight was increased with an increase in the light intensity. These findings are in agreement with many other earlier reports (Lien et al. 2007, 2008).

Feed conversion ratio (FCR) is calculating from the feed intake divide to body weight (Lien et al. 2008; Cao et al. 2012). Therefore, factors that affecting the body weight and feed intake will be affected on FCR. The best FCR (in all rearing phases) was calculated for chickens in green light pens. The interaction of colour and light intensity show that in each light colour, the FCR was decreased with an increase in the light intensity. The chicken’s visibility is poor in the low-frequency light such as green light. Therefore, the chicken is more relaxed in green light, and it has not the extra activity, and aggression (Olanrewaju et al. 2006; Senaratna et al. 2015). So, the significant percentage of the energy and nutrient of feed are used to grow muscles and increase the body weight, consequently, FCR is reduced. In the present study, with increasing the light intensity from 5 to 50 lux, FCR was reduced. Reducing FCR is means increasing the efficiency of the use of consumed feed by the chicken for the body weight. The chicken is stimulated for eating the feed by the light with the intensity of 50 lux. In general, FCR in coloured lights of 50 lux is better than 5 lux. On the other hand, the best FCR was observed in the green light of 50 lux (in the whole phase).

#### Table 7. Effect of the colour and light intensity on the blood metabolites, and thyroid hormones – part 2.

| Factors                  | HDL A (mg/100ml) | LDL B (mg/100ml) | VLDL C (mg/100ml) | Calcium (mg/100ml) | Phosphorus (mg/100ml) | T3 D (ng/ml) | T4 E (ng/ml) | TSH F (ng/ml) |
|--------------------------|------------------|------------------|-------------------|--------------------|----------------------|--------------|--------------|---------------|
| **Light colour**         |                  |                  |                   |                    |                      |              |              |               |
| Green                    | 101.38           | 28.89            | 18.98             | 10.03              | 7.18                 | 1.51         | 2.03         | 0.93          |
| Yellow                   | 104.00           | 27.00            | 17.50             | 9.91               | 7.08                 | 1.42         | 2.68         | 0.92          |
| Red                      | 103.67           | 29.67            | 19.02             | 9.47               | 7.15                 | 1.24         | 2.29         | 0.95          |
| SEM                      | 7.48             | 6.76             | 3.18              | 0.69               | 0.77                 | 0.13         | 0.42         | 0.38          |
| p Value                  | .09              | .06              | .06               | .08                | .10                  | .08          | .07          | .08           |
| **Light intensity**      |                  |                  |                   |                    |                      |              |              |               |
| 5 lux                    | 101.95           | 28.53            | 18.46             | 9.26               | 6.99                 | 1.43         | 2.54         | 0.89          |
| 50 lux                   | 103.18           | 28.40            | 19.09             | 9.54               | 7.53                 | 1.33         | 2.20         | 0.90          |
| SEM                      | 6.47             | 5.85             | 2.24              | 0.46               | 0.67                 | 0.07         | 0.29         | 0.27          |
| p Value                  | .06              | .10              | .10               | .11                | .08                  | .09          | .08          | .07           |
| **Colour × intensity**   |                  |                  |                   |                    |                      |              |              |               |
| Green × 5 lux            | 102.25           | 28.15            | 18.60             | 9.97               | 7.17                 | 1.32         | 2.66         | 0.89          |
| Green × 50 lux           | 101.55           | 27.63            | 17.37             | 10.10              | 7.19                 | 1.41         | 2.40         | 0.91          |
| Yellow × 5 lux           | 100.17           | 28.83            | 17.50             | 9.86               | 6.94                 | 1.39         | 2.92         | 0.89          |
| Yellow × 50 lux          | 103.83           | 29.17            | 17.37             | 9.76               | 7.01                 | 1.38         | 2.45         | 0.90          |
| Red × 5 lux              | 101.67           | 28.17            | 17.66             | 9.10               | 7.22                 | 1.39         | 2.76         | 0.89          |
| Red × 50 lux             | 102.13           | 28.57            | 17.83             | 10.05              | 7.88                 | 1.40         | 2.83         | 0.90          |
| SEM                      | 12.95            | 11.70            | 4.49              | 1.20               | 1.34                 | 0.18         | 0.59         | 0.09          |
| p Value                  | .07              | .07              | .08               | .07                | .06                  | .07          | .07          | .08           |

SEM: Standard error of the mean

A: High-density lipoprotein.

B: Milligram per 100 millilitres.

C: Low-density lipoprotein.

D: Very low-density lipoprotein.

E: Triiodothyronine.

F: Nano gram per millilitre.

G: Tetraiodothyronine.

H: Thyroid stimulating hormone.

Non common superscripts in each column indicate the significant statistical difference (p < .05).
leading to stress, effect on the feed intake and body activity. Considering the favourable effect of green light (5 lux and 50 lux) on the performance traits, it is recommended for using green light produce by incandescent bulbs for rearing the broiler chickens. Further researches are suggested to see the combine effects of different light colours with different intensities on the tested parameters.

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Disclosure statement

The authors declare that there is no conflict of interest associated with the paper. The authors alone are responsible for the content and writing of this article.

Ethical Approval

The experimental method was approved by the national committee for ethics in biomedical research of Iran.

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