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Effect of different light intensities and colors on growth performance and reproductive characteristics in Japanese quails

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Abstract: Light is one of the most important environmental factors in quail farming, as it has a significant impact on production efficiency and reproductive characteristics. The purpose of this study was to determine the effect of different light intensities and colors on production performance in Japanese quails. For the first experiment, 200 Japanese quails were divided into five treatment groups, each with four replicates (10 birds in each). The birds in the control treatment were exposed to a light intensity of 20 lux, while the other four treatment groups were exposed to light intensities of 10 lux, 15 lux, 25 lux, and 30 lux. The experiment lasted for 6 weeks. Weight gain and dressing percentage were higher in birds that received 25 lux light intensity than in other groups ($p < 0.05$), however, feed intake, feed conversion ratio, and relative organs weights were not affected by different light intensities ($p > 0.05$). The length of the oviduct was higher in birds that received 30 lux and it was lower ($p < 0.05$) in those that received 15 lux. In the second experiment, 200-day-old Japanese quail chicks were divided into five treatment groups, each with four replicates (10 birds in each). The treatments included a control group of compact fluorescent White light, while, other group received Red LED light (630 nanometers), White LED light (490 nanometers), Blue LED light (220 nanometers), and Green LED light (550 nanometers). The experiment lasted for 8 weeks. Body weight gain, FCR, dressing percentage, oviduct length, and the number of ovarian follicles were improved in birds that received Red LED light than other colors lights ($p < 0.05$). Birds that received Red LED light had higher egg weight, egg-shell thickness, yolk index, albumen, and yolk percentage than other treatments ($p < 0.05$). In conclusion, quails perform improved growth performance and dressing percentage when they are exposed to 20 and 25 lux light intensities, as well as red LED light.

Keywords: Light intensities, light colors, growth performance, carcass response, reproductive characters

1. Introduction

Quail is small avian species that belongs to the Pheasant family. Brown-colored Japanese quails are commonly reared on a commercial scale for meat or eggs [1]. Commercial quail is an alternative source of animal protein foods, particularly in developing countries. Japanese quail are mostly kept in battery cages for the benefit of their eggs and meat [2]. This species is well adapted to raising conditions with hostile environments, exhibiting quick development, early sexual development (42 days old enough), high egg production, low feed admission, and high infection resistance [3].

Light stimulates the gonadal cycle, eventually causing the start of lay by animating the nerve center zone through the eyes or the pineal organ to deliver gonadotropin-releasing hormone, which invigorates the front pituitary to deliver follicle-stimulating hormone and luteinizing hormone [4]. The use of adequate lighting programs is critical for egg production because light boost directly influences the physiological reactions of the avian species [5]. Light stimulates the release of sexual hormones, can speed up, or delay sexual development, and stimulates egg laying. These hormones are responsible for the production of significant sex steroid hormones such as testosterone, estrogen, and progesterone. Low light intensity generally decreases activity, resulting in more resting and dozing, as a result, quicker weight gain [6].

Lighting is regarded as a critical managerial technique in poultry production and consists of at least three distinct aspects: wavelength of light, the intensity of light, and duration of light. Lighting in poultry is essential for the development and normal functioning of the reproductive system as well as the growth of the bird. It is a powerful environmental factor that regulates several behavioral and physiological progressions [7]. Light is electromagnetic radiation that can be seen. Light is a subset of the more

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complex physical phenomenon known as electromagnetic radiation. The use of materials that absorb one wavelength and then give away another allows for variations in radiation wavelength [8].

The primary sense organs are the eyes and vision is one of the ways that birds are affected. Several studies have been conducted to evaluate the effects of various types of light sources on the performance, behavior and financial aspects of poultry birds [9–11]. Poultry species also detect light using their eyes (retinal photoreceptors) and photosensitive cells in their minds (extra-retinal photoreceptors). Most notably, light influences the secretion of a few hormones that regulate development, growth and reproduction performance [12]. Differential photostimulation of the retina and extra-retinal sites is determined by the retina's sensitivity to different wavelengths of green, yellow and red light and its ability to penetrate body tissues [11]. Red light with a wavelength of 675 nm is more gonado-stimulatory than light with a narrow wavelength of 450 to 475 nm [13].

In Pakistan, few studies are published on different light intensities and LED lights for egg-laying quails and limited information has been found in the literature linking various colors of monochromatic LED lights and light intensities to the advancement of quail reproduction. Therefore, the aim of this study was to determine the effect of different monochromatic led light colors and intensities on Japanese quail growth and reproductive performance.

2. Materials and methods

2.1. Location

The work of research was performed at Raja Muhammad Akram Farm Animal Nutrition, Directorate of Farms, the University of Agriculture Faisalabad, Punjab, Pakistan via letter no. 19953-56.

2.2. House management

Before the arrival of quail chicks, the poultry house was cleaned, disinfected and sanitized. The house was disinfected with a mixture of limestone water and phenyl. Feeders and drinkers were disinfected by dipping them in $KMnO_4$ solution for one h and then washing them with tap-water. During the first week, a temperature of 32 °C was provided. The temperature was then gradually reduced by 3 °C per week until it reached 24 °C. The light bulbs were installed at 2 feet bird height and light intensity was calculated with the help of lux meter at birds head level. Each given treatment was insulated with black fabric to avoid interference of individual light colors and intensities. Birds were kept under floor litter system, chick paper was used until brooding period, after that wood dust was used as bedding material. Feed composition is given in Table 1. Feed was given ad libitum twice daily. The same prepared feed was given both for the starter and finisher phases.

2.3. Experimental birds

In Experiment I, 200 one day old quails were divided into five treatment groups, each with four replicates (10 birds in each). The birds in the control treatment were exposed to a light intensity of 20 lux of LED light, while the other four treatment groups were exposed to light intensities of 10 lux, 15 lux, 25 lux, and 30 lux. The experiment was lasted for 6 weeks.

In Experiment II, 200-day-old Japanese quail birds were divided into five treatment groups, each with four replicates (10 birds in each). The treatments included a control group of compact fluorescent light, Red LED light, White LED light, Blue LED light, and Green LED light. The experiment lasted for 8 weeks for collecting eggs and measuring egg quality characteristics.

2.4. Data collection

2.4.1. Growth performance

All the chicks were weighed and recorded by using a digital weighing balance (DIGITONE tabletop scale) to get the initial body weight just after their arrival. Weekly body weight was recorded and the average weight per bird (each replicate was weighed as a whole, then the average weight was calculated) according to their corresponding replicates was calculated at the completion of each week.

Feed intake (special kind inverted iron feeding trays were placed to avoid scattering feed) was calculated by dividing the refusal of the whole week by the total feed offered during that period. Feed intake/bird was determined by using the following formula:

$$\text{Feed intake/bird} = \frac{\text{Feed offered} - \text{Refusal}}{\text{Birds per replicate}}.$$

Feed conversion ratio is used to estimate the efficiency of birds to convert the feed into weight and it was estimated through the following formula

$$\text{Feed conversion ratio} = \frac{\text{Feed intake (g)}}{\text{Weight gain (g)}}.$$

2.4.2. Carcass characteristics

At the end of the experiment, two birds from each replicate of each experimental treatment were chosen at random and slaughtered. After slaughter and feather removal, the head, viscera, and shanks were separated. Following that, data such as live body weight, carcass weight, breast weight, thigh weight, heart weight, liver weight, and gizzard weight were recorded. The information obtained was used to calculate the dressing percentage, breast weight percentage, thigh weight percentage, liver weight percentage, heart weight percentage, and gizzard weight percentage.

2.4.3. Reproductive characteristics

At the end of the experiment, the number of ovarian follicles (yellow follicles) and the length of the oviduct were also calculated to evaluate reproductive characteristics (sample was taken after post mortem from two birds). At

Table 1. Composition of the ration offered to the experimental birds.

Ingredients	**Basal Diet**
Corn	19.51
Rice tips	20
Rice polish	5
Soybean meal	28.25
Limestone	1.08
Canola meal	16
Vegetable oil	1.97
Fish meal	2
Guar meal	1
Feather meal	4
Sodium Biocarbonate	0.209
Salt	0.069
L-Lysine sulphate	0.656
DL-methionine	0.222
*Extra XAP	0.01
Phytase	0.01
Total	100
Nutrient composition	
Dry matter	89.12
Crude protein	24
Ether extract	4.32
Calcium	0.9
Available phosphorus	0.45

*Extra XAP is a commercial enzyme that contains endo-1,4-beta-xylanase, protease, and alpha-amylase.

the Poultry Science lab of Institute of Animal and Dairy Sciences, University of Agriculture Faisalabad, four eggs from each replicate were collected to calculate eggshell thickness, yolk index, albumen percentage, yolk, and eggshell percentage.

2.5. Statistical analysis

The data from the various light treatments were analyzed using a completely randomized design, and the means were compared using Tukey's Test. Collected data were tested for normality and after confirming the normal distribution of the data, parametric statistics were applied through one-way ANOVA in Minitab software. Significant treatment means were separated through Fisher's least significant difference test considering the probability level of ($p \leq 0.05$) [14,15].

3. Results

Experiment 1 (Light intensities)

Growth performance

Starter phase: Feed intake, weight gain, and FCR were not affected by different light intensities during starter phase ($p > 0.05$; Table 2).

Finisher phase: Different light intensities had no effect on feed intake, weight gain, and FCR during finisher phase ($p > 0.05$; Table 2).

Overall period: Weight gain was higher in birds that received 25 lux light intensity than other groups which are 15 lux, 10 lux, and 30 lux ($p < 0.05$); however, feed intake and FCR were not affected by different light intensities ($p > 0.05$; Table 2).

Carcass characteristics: Carcass characteristics of birds received different light intensity is shown in Table 3. Dressing percentage was higher in birds that received 25 lux light intensity than other groups ($p < 0.05$); however, relative organ weights (heart and liver) were not affected besides gizzard weight higher in 15 and 20 lux intensities ($p > 0.05$).

Reproductive characteristics: Length of oviduct of Japanese quail was higher in 30 lux light intensity ($p < 0.05$; Table 3). Treatment T5 (30 lux) was observed higher length of oviduct and it was lower in T2 (15 lux) ($p < 0.05$).

Table 2. Effect of different light intensities on growth performance of Japanese quails.

Parameter	Treatments					SEM	P-value
	10 lux	15 lux	20 lux	25 lux	30 lux		
1–3 weeks							
Feed intake (g)	247.99	251.25	250.08	252.45	245.55	3.7	0.73
Weight gain (g)	78.92	81.91	77.02	87.57	76.69	3.4	0.19
FCR	3.14	3.07	3.25	2.88	3.2	0.12	0.7
4–6 weeks							
Feed intake (g)	546.6	554.31	554.08	571.91	555.7	4.7	0.13
Weight gain (g)	88.43	86.13	84.72	104.33	89.52	6.5	0.06
FCR	6.18	6.44	6.54	5.48	6.21	0.3	0.25
Week total 6							
Feed Intake (g)	794.59	805.56	804.16	824.17	801.25	6.85	0.07
Weight gain(g)	167.35^{b}	168.03^{ab}	161.74^{b}	191.91^{a}	166.22^{b}	5.52	0.01
FCR	4.75	4.79	4.97	4.29	4.82	0.15	0.07

SEM: Standard error of mean, $p > 0.05$ (nonsignificant), $p < 0.05$ (significant)
$^{a–b}$ Values different in column differ significantly ($p < 0.05$)
FCR: Feed conversion ratio (feed intake/weight gain)

Table 3. Effect of different light intensities on carcass and reproductive characteristics.

Parameter	Treatments					SEM	P-value
	10 lux	15 lux	20 lux	25 lux	30 lux		
Dressing percentage	67.89^{b}	67.59^{cd}	67.49^{d}	68.72^{a}	67.79^{bc}	0.06	0.001
Breast weight (%)	30.44	30.37	30.42	30.93	30.61	0.18	0.224
Thigh weight (%)	23.44	23.37	23.46	23.91	23.61	0.17	0.235
Gizzard weight (%)	2.13^{ab}	2.27^{a}	2.25^{a}	1.81^{b}	2.05^{ab}	0.08	0.006
Heart weight (%)	1.06	1.10	1.13	0.97	1.10	0.04	0.074
Liver weight (%)	2.15	2.10	1.93	2.07	2.25	0.07	0.079
Length of oviduct (cm)	12.90^{ab}	10.60^{b}	13.25^{ab}	12.67^{ab}	16.17^{a}	0.863	0.007

SEM: Standard error of mean, p n 0.05 (nonsignificant), $p < 0.05$ (significant)
$^{a–b}$ Values different in column differ significantly ($p < 0.05$)

Experiment 2 (LED colors)

Growth performance

Starter phase: The highest value of feed intake was significantly higher Green LED light group ($p < 0.05$; Table 4). Body weight gain was significantly higher in birds that received Red LED light ($p < 0.05$). The feed conversion ratio was improved in birds that received Green LED light ($p < 0.05$).

Finisher phase: Feed intake was significantly higher in birds that received Green LED light during finisher phase ($p < 0.05$; Table 4). Birds that received Red LED light had significantly higher weight gain than others light colors ($p < 0.05$). Better FCR was recorded in quails that received Red LED, white LED, and blue LED group than color light colors ($p < 0.05$).

Overall period: The significantly highest value of feed intake was shown by Green LED light group as compared to Red LED, White LED, control CFL and Blue LED light groups ($p < 0.05$) (Table 4). The significantly highest value of body weight gain was shown by Red LED light group as compared to White LED, Control CFL, Green LED, and Blue LED light groups ($p < 0.05$). The feed conversion ratio was improved in birds that received Red LED light followed by Blue LED, control CFL, White LED, and Green LED light groups, respectively ($p < 0.05$).

Carcass characteristics: Birds that received Red LED had higher dressing percentage compared to other treatment groups ($p < 0.05$; Table 5). Red LED and Blue LED had higher heart, liver, and gizzard percentages, respectively as compared to other treatments ($p < 0.05$).

Reproductive characteristics: Red LED light had higher oviduct length and number of ovarian follicles as compared to other treatment groups ($p < 0.05$; Table 6).

Egg quality parameters: At the end of experiment, four eggs from each replicate were selected randomly, brought to poultry lab for evaluation of egg quality. Birds received Red LED light had higher egg weight, egg shell thickness, yolk index, albumen and yolk percentage than other treatments ($p < 0.05$; Table 6).

Table 4. Effect of LED light colors on growth performance of Japanese quails.

Parameter	Treatments					SEM	P-value
	CFL	Red LED	White LED	Blue LED	Green LED		
Week 1–4							
Feed intake (g)	264.88^{c}	271.25^{b}	272.13^{b}	204.50^{d}	312.50^{a}	1.45	0.001
Body weight gain (g)	109.00^{b}	121.38^{a}	110.13^{b}	99.38^{c}	103.25^{c}	0.93	0.001
FCR	2.43^{b}	2.24^{c}	2.47^{b}	2.06^{d}	3.03^{a}	0.02	0.001
Week 5–8							
Feed intake (g)	545.50^{c}	557.63^{b}	553.25^{b}	483.63^{d}	611.63^{a}	1.37	0.001
Body weight gain (g)	90.00^{b}	96.88^{a}	91.88^{b}	79.00^{c}	81.50^{c}	0.98	0.001
FCR	6.06^{bc}	5.76^{c}	6.02^{bc}	6.13^{b}	7.51^{a}	0.09	0.001
Week total 8							
Feed intake (g)	810.38^{c}	828.88^{b}	825.38^{b}	688.13^{d}	924.13^{a}	2.55	0.007
Body weight gain (g)	199.00^{c}	218.25^{a}	202.00^{b}	178.38^{e}	184.75^{d}	0.48	0.001
FCR	4.07^{b}	3.80^{d}	4.09^{b}	3.86^{c}	5.00^{a}	0.02	0.001

SEM: Standard error of mean, $p > 0.05$ (nonsignificant), $p < 0.05$ (significant)
$^{a–d}$ Values different in column differ significantly ($p < 0.05$)
FCR: Feed conversion ratio (feed intake/weight gain)

Table 5. Effect of LED light colors on carcass characteristics.

Carcass characteristics	Treatments					SEM	P-Value
	CFL	Red LED	White LED	Blue LED	Green LED		
Live body weight (g)	209.62^{b}	225.25^{a}	209.12^{b}	185.12^{d}	190.87^{c}	0.54	0.001
Carcass weight (g)	119.23^{b}	133.05^{a}	110.61^{c}	96.40^{e}	100.45^{d}	0.75	0.001
Dressing percentage	56.87^{b}	59.07^{a}	52.89^{c}	52.07^{c}	52.62^{c}	0.29	0.001
Thigh weight (%)	40.41^{a}	39.22^{bc}	39.38^{b}	38.83^{c}	39.06^{bc}	0.094	0.001
Chest weight (%)	52.04^{c}	53.31^{a}	52.77^{b}	52.76^{b}	52.81^{b}	0.101	0.001
Liver weight (%)	2.45^{d}	2.48^{d}	2.59^{c}	2.79^{a}	2.70^{b}	0.015	0.001
Gizzard weight (%)	3.93^{d}	3.67^{e}	4.17^{c}	4.53^{a}	4.29^{b}	0.025	0.001
Heart weight (%)	1.14^{b}	1.30^{a}	1.07^{c}	1.06^{c}	1.11^{bc}	0.015	0.001

SEM: Standard error of mean, $p > 0.05$ (nonsignificant), $p < 0.05$ (significant)
$^{a–e}$ Values different in column differ significantly ($p < 0.05$)

Table 6. Effect of LED light colors on reproductive and egg quality characteristics.

Parameter	Treatments					SEM	P-Value
	CFL	Red LED	White LED	Blue LED	Green LED		
Reproductive characteristics							
Length of oviduct (cm)	11.2^{b}	18.2^{a}	11^{b}	7.8^{c}	8.5^{c}	0.34	0.001
No. of ovarian follicles	9^{b}	15.7^{a}	8.1^{bc}	5.7^{c}	6.5^{bc}	0.62	0.001
Egg quality characteristics							
Egg weight (g)	11.43^{b}	13.2^{a}	10^{b}	11^{b}	10.77^{b}	0.5	0.001
Egg shell thickness (mm)	0.18^{b}	0.25^{a}	0.13^{c}	0.15^{bc}	0.13^{c}	0.01	0.001
Yolk index	39.8^{b}	45.6^{a}	36.2^{c}	38^{bc}	37.4^{c}	0.52	0.001
Albumen (%)	58.1^{b}	62.6^{a}	57.7^{b}	58.3^{b}	58.7^{b}	0.41	0.001
Yolk (%)	30.3^{b}	37.1^{a}	28.8^{b}	30.2^{b}	29.2^{b}	0.47	0.001

SEM: Standard error of mean, $p > 0.05$ (nonsignificant), $p < 0.05$ (significant)
$^{a-c}$ Values different in column differ significantly ($p < 0.05$)

4. Discussion

Light enables avian species to establish rhythmicity and synchronize numerous basic capacities, such as internal body temperature and various metabolic processes that promote feed intake and digestion. Similarly, light stimulates the secretory role of a few hormones that primarily control development, reproduction, and growth [12].

Different light intensities had a significant effect on body weight gain. N'zue et al. [16] found that quails exposed to artificial light during the start-up phase gained significantly more weight than those exposed only to natural light. Hassan et al. [17] discovered that the birds raised under red LED light have significantly high ovary weight and large number of ovarian follicles as compared to other light colors treatment groups. Senaratna et al. [18] investigated whether the weight gain of birds was affected by the intensity of different colored lights. The current findings contradict the findings of Blatchford et al. [6], who investigated the effects of three photo-phase light intensities (5, 50, and 200 lux) on broiler action designs, invulnerability and eye and leg state. There was no significant difference in weight gain between medicines, even though there was an age effect, with broiler birds expanding in weight with age.

The LED light colors interacted with and significantly affected quail feed intake in this experiment. The green LED light group had the highest feed intake, as demonstrated by Mohamed et al. [19] who performed an experiment in which they gave chicken three treatments: white, green, and blue light. The results showed that broiler chickens have grown under blue light and green light had higher feed intake. This could be due to fewer physiological changes in response to stress, resulting in calm behavior. According to Sultana and Hassan [20], feeding was not influenced by light color in the morning but was influenced in the afternoon. Feed intake results contradict the findings of Al-hsenawi et al. [10], who discovered that feed consumption was higher in birds raised under white light during the first three weeks compared to other light colors (red, green, and blue), indicating that there was an increase in feed consumption for birds raised under the influence of white light compared to other light colors.

Throughout the experiment, different light-intensity treatments had no effect on feed intake. These findings are consistent with those of Fidan et al. [21] who discovered that differences in light intensity groups for FCR were not significant for days 1 to 42. Nunes et al. [22] also found that the different bulb types and intensities had no effect on feed intake. Ahmad et al. [23] discovered that light intensity has no effect on broiler chicken feed consumption. Deep et al. [24] discovered that feed intake was influenced by light intensity. According to N'zue et al. [16] quail feed consumption showed a significant difference in feed intake across all subgroups. These findings contradict the findings of Hassan et al. [17] who discovered that increasing light strength from 10–375 lux increased feed intake linearly.

In this experiment, the colors of the LED lights influenced the feed conversion ratio. According to Firouzi et al. [25], the effects of various colored lights on broiler performance in four farmhouses mentioned green light, sunny yellow, blue colored light, and red light and their results showed that the broilers reared under blue and yellow colored light had the best and weakest production performance results, respectively. The lower feed intake in birds reared under blue light compared to other light colors may be due to blue light's calming effect, in which birds become less active and less stressed. However, the FCR result was only significant at the end of the trial, indicating that blue light was superior to yellow and red light. According to Assaf et al. [26] using green color light among broilers resulted in a significant reduction in feed conversion rate for the entire fattening period, which corresponds to the results of the first four weeks in which feed conversion value was lowest in green colored LED light.

Using different light intensities did not improve the feed conversion ratio significantly. These findings are consistent with the findings of Zhao et al. [27], who determined that photoperiods and light intensities had no effect on the feed conversion ratio of broiler chickens. Memon et al. [28] demonstrated that the quail feed conversion ratio was evaluated, but the variation was not significant across intensities. Hassan et al. [17] demonstrated that there were no statistically significant differences in light intensity at 10, 50, and 250 lux based on the feed conversion ratio. These findings contradict those of Aguiar et al. [29] who discovered that quails exposed to natural light had a higher feed conversion ratio than those exposed to other lighting programs, which did not differ from one another. According to Mohammed et al. [8] quails from low-light intensity groups have the best feed conversion ratio. Ahmad et al. [23] discovered that the average values of FCR of broiler chickens kept under various light conditions differed significantly between numerous treatment groups.

Carcass characters were also affected and significantly different among LED light experimental treatments. The red LED group had the best results, with higher live body weight and carcass weight compared to all other treatments, whereas Seber et al. [30] discovered a higher yield of thigh muscles, carcass weight, and breast weight for chickens exposed to blue LED colored lighting. When compared to a single type of light, monochromatic LED light blends (green and blue) can increase chicken body, thigh weight, breast weight, and carcass weight. Mohamed et al. [19] conducted an experiment in which they exposed broiler birds to three experimental treatments: white light, green light, and blue light. The results showed that birds raised under blue and green light had higher body weight, carcass weight, bursa, liver, and spleen.

According to the findings, different light intensities did not affect carcass characteristics. Bobadilla-Mendez et al. [31] reported that at 8 weeks, advanced intestine weight and length, as well as liver weight, were detected in birds kept in white LED. This type of lamp was also associated with lower breast weight. Deep et al. [24] discovered that broilers raised under 1 lux had heavier wings as a proportion of live weight than other treatments. These findings contradict those of Fidan et al. [21] who discovered that cold and hot carcass weight, whole breast meat and wing weight were lower in the faint, decreasing light intensity group than in the 20 lux light group. The impacts of photoperiod length and light intensity on body qualities were not critical, measurably.

In terms of reproductive performance, the length of the oviduct and ovarian follicles were greater in the red LED light group compared to all other treatments, as stated by Gongruttananun and Guntapa [32], who demonstrated more dynamic advancement of ovarian follicles in hens exposed to red light, particularly as the avian species were enlightened clearly with red light in shut restriction. This was supported by evidence of increased blood estradiol fixations in the avian species treated with red light. Estradiol is an ovarian hormone that has a variety of reproductive functions in domestic hens, including the maintenance of calcium metabolism for eggshell formation. Huber-Eicher et al. [33] concluded that red-colored light has a significant effect on sexual development in laying hens and their study demonstrated that the reason for this effect was due to specific wavelength rather than the intensity of light. Generally, red light stimulates egg production effectively, whereas green or blue light has almost no effect. Among commercial layers, egg production was entirely influenced by light colors during the first and second seasons, with the best number of eggs delivered in the group that was treated with red light. Furthermore, eggs laid under blue or green light were consistently larger than those laid under red light. Firouzi et al. [25] demonstrated that different colored lights had no effect on egg quality, but they also suggested that these lights could be used in the production of quail eggs. According to Raziq et al. [34] performance and reproductive traits, as well as the hormonal profile of layer production, varied significantly depending on light sources, with LEDs outperforming both fluorescent and incandescent light sources.

Green LED light color treatment oviduct length was found to be significantly longer than Red LED light, but comparable to the other treatments. These findings are consistent with those of N'zue et al. [16], who discovered that the oviduct of 64-day-old hens exposed to green LED lighting was smaller than those exposed to fluorescent lighting. According to Baxter [35], higher wavelengths are more effective at stimulating the reproductive axis and increasing ovarian activity. Shorter wavelengths appeared to be less effective at entraining oviposition and ovulation, as hens exposed to green light showed a lack of synchronicity between light schedule and time of lay.

Conclusion

Based on these findings, it is possible to conclude that growth performance, carcass quality, and reproductive performance improve in birds exposed to 20 and 25 lux light intensities of LED light, as well as red LED light.

Conflict of interest
The authors declare no conflict of interest.

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