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Growth Performance of Japanese Quail (*Coturnix coturnix japonica*) Utilizing Different Light Bulb Color

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Abstract
This study was conducted to determine the growth performance of Japanese Quail (*Coturnix coturnix japonica*) utilizing different light bulb colors in terms of growth performance which include body weight, feed consumption, feed efficiency, average daily gain, and mortality rate. A total of 192-day-old chicks (160 females and 32 males) were utilized and randomly assigned to 16 cages using a Randomized Complete Block Design (RCBD). Four experimental treatments were tested: T1 – yellow (control), T2 – green, T3 – red, and T4 – blue, with four replicates per treatment (10 females and 2 males per replicate). The results demonstrated that LED light color significantly influenced various growth performance metrics. Specifically, T3 – red resulted in the highest body weight, T2 – green led to the greatest average weekly gain, and T4 – blue showed superior feed consumption and feed efficiency. Mortality rates, however, did not differ significantly among treatments. Recommendations from the study include the use of red LED lights to optimize body weight, green lights for improved average weekly gain, and blue or yellow lights to reduce feed consumption.

Keywords: Growth Performance, Japanese Quail, Light Bulb Color, LED

Introduction

Poultry farming is a good idea for establishing an animal farm; it is also good for business purposes since the human body needs protein to consume. Poultry farms are known as a great source of protein, which is why the demand for their production is high. At some point, raise birds for their meat, eggs, and feathers. It has become important in daily lives since birds are rich in vitamins. In one early work by Giridhar Athrey (2020) [11], over the last century, production of poultry species has seen astonishing gains around the world and played a major role in reducing global hunger. The emergence of high-performing commercial quail bird (meat-type and egg-producing) varieties has expanded the availability of affordable, nutritious animal protein both in the developed world and in emerging economies. The availability of low-cost, nutritious animal protein has increased in both developed and developing countries as a result of the development of high-performing commercial breeds of broiler chickens (chickens raised for meat) and layer hens (hens raised for egg production).

The Japanese quail (*Coturnix coturnix japonica*), also known as the coturnix quail, is a species of Old World quail found in East Asia. Originally considered a subspecies of the common quail, it is now considered a separate species. The Japanese quail has played an active role in the lives of humanity since the 12th century and continues to play major roles in industry and scientific research. Where it is found, the species is abundant across most of its range. Currently, there are a few true breeding mutations in the Japanese quail. The breeds from the United States are Texas A&M, English white, golden range, red range, Italian, Manchurian, Tibetan, rosetta, scarlett, roux dilute, and golden tuxedo. Japanese Quail (*Coturnix coturnix japonica*) belong to the order Galliformes, family Phasidae, genus Coturnix, and species Japonica. It has several breeds with different functions or uses for humans; some are raised for pets, for meat production (bob white quails and brown quails), and for eggs (Japanese quail).

According to Taculao (2021) [33], there are different breeds found in the Philippines, such as Native, Japanese Taiwan, Japanese Seattle, Negro, Tuxedo, and Silver. First, Native, commonly known as "pugo," which is usually found in fields and forests but not suitable for commercial production, so it is raised as a pet. Next is Japanese Taiwan, also known as the Chinese Quail and commonly raised in the Philippines. Mature female quail have a tan throat and breast, while males have a reddish brown breast

and throat. Despite having a lower egg production, it can still lay eggs for up to a year. Japanese Seattle strain country origin was America; it is also similar to Japanese Taiwan, but with a larger body, egg, and breasts that range from rusty to reddish brown. It can lay eggs for up to 12 months and is highly recommended for commercial production because of its capability as a heavy egg producer. Though wild and timid by nature, these quails are rigorously raised to provide meat and eggs for a "luxury" market.

Quail farming is a lucrative business because of its incredibly quick growth and early sexual maturity. Next is the Negro, which has a black or grayish black feather, and this breed is usually used as a pet. Tuxedo is black with a white spot on the breast and is suitable for commercial layer quail farming since it is known as a highly egg-laying quail breed. Last is Silver; this breed came from the Canaan Valley, Egypt, is known as a good breeder, and can be used as a pet. The concept of "Quail Raising Guide" by Jose R. (2022) [15] stated that quail, unlike some other fowl, are not delicate birds. They can be raised in any suitable and comfortable place in the house. The birds do not easily contract fowl diseases common to poultry, especially chickens.

According to Vali Nasrollah (2008) [22], the Japanese quail has several aspects that account for the utility of this bird. First, it has attained economic importance as an agricultural species producing eggs and meat that are enjoyed for their unique flavor. Egg production is important in Japan and Southeast Asia, while meat is the main product in Europe. Second, the low maintenance cost associated with its small body size (80–300 g), coupled with its short generation interval (3–4 generations per year), resistance to diseases and high egg production, and rendered it an excellent laboratory animal. Third, the Japanese quail is also the smallest avian species farmed for meat and egg production. It has thus been extensively used in many studies. The Japanese quail is bred for egg and meat production. Few studies have been published on egg production, but reports on quail growth and body composition are numerous. Some of the estimated genetic parameters for various traits of Japanese quail were reported by several workers.

In terms of raising, the important thing to consider to be successful in quail raising is to practice proper cultural management. The extent of the cultural management activities is determined by possible quail performance. Proper location for the project shall be identified to avoid losses by predators and stress. A quiet place must be chosen since quails are easily startled by noise, which results in stress. The quail has a high temperature. They required adequate airflow in order to comfortably lay eggs. It has been demonstrated that quails produce more when grown in climates with temperatures between 31°C and 35°C. Quail farming is similar to chicken farming but takes up much less space. The east-west position should be taken into consideration, as quail cages need to be well-ventilated and shielded from temperature disturbances like extremely hot or cold weather. Predatory animals like cats, rats, and birds should be kept away from it. Quails should not be released since they lack a homing instinct and become lost.

Light is important in poultry, from newly hatched to fully grown bird. This light can ensure their health by helping the quail find their way in their cage or house whenever they need to find food and water. Baby chicks need 24 hours of light for the first 48 to 72 hours of life to ensure that they find food and water and use a 9-watt LED bulb for every 200 square feet of floor space, while laying quail need 14 to 16 hours of light per day. The feed efficiency can be seen once their size and weight increase. It also stimulates them and makes them active. This lighting has such a vital role in poultry farms that it can even affect or influence the performance of quail with the correct intensity of exposure. Avians have a pineal gland, which is found in their brain and is activated by light. To improve their laying, the lighting program is a must since it stimulates the hormone cascade. According to the past study of Bradley Hogshead in 2015, it has been discovered that various light wavelengths have an impact on egg quality, immunological response, and growth rate in broiler chickens. Egg production in laying hens exposed to red light has increased, and weight gain in broilers exposed to blue and green light has increased.

The Japanese quail is known for its rapid sexual maturity and small size, which is why this species was chosen for this study. The researchers aim to determine the effect on the growth performance of Japanese quail (*Coturnix coturnix japonica*) utilizing different light bulb colors. In order to enhance their performances, different light bulb colors were used to observe how these LED lights can affect the growth performance of Japanese quail utilizing different light bulb colors.

Methodology

This study was conducted at Barangay Bulihan, Famy, Laguna, from May 14, 2023, to September 15, 2023 to determine the growth performance of Japanese quail *(Coturnix coturnix japonica)* utilizing different light bulb colors in terms of growth performance which include body weight, feed consumption, feed efficiency, average daily gain, and mortality rate. A total of 192 day-old chicks (160 females and 32 males) were utilized and randomly assigned to 16 cages using a Randomized Complete Block Design (RCBD).

Four experimental treatments were tested using different light-emitting diode colors were: T1 – 10 watts light-emitting diode (LED) color yellow (control); T2 – 10 watts light-emitting diode (LED) color green; T3 – 10 watts light-emitting diode (LED) color red; and T4 – 10 watts light-emitting diode (LED) color blue. Each treatment was replicated four times with 12 heads of quails (10 females and 2 males per replicate).

T1R1	T2R4	T3R4	T4R3
T2R3	T3R3	T4R2	T1R4
T3R2	T4R1	T1R3	T2R2
T4R4	T1R2	T2R1	T3R1

T1 – Yellow Light Bulb (Control) (10 Watts)
T2 – Green Light Bulb (10 Watts)
T3 – Red Light Bulb (10 Watts)
T4 – Blue Light Bulb (10 Watts)

Fig 1: Layout of the experimental units of the study

The data were organized and presented in tabular form, then analyzed using Analysis of Variance (ANOVA) to determine significant differences among treatment means. When significant results were found, the Least Significant Difference (LSD) test was applied to identify specific differences between treatments. Data analysis was performed using the Statistical Tool for Agricultural Research (STAR) software.

Results and Discussion

Body Weight

Body weight refers to the product of body mass of the bird. After hatching, Japanese quail weigh 8–9g, compared to 10–11g for eggs. Adult body weight ranges from 200–250g, while the average weight at 5–6 weeks is 180–200g.

The body weight of quails from the different treatments from the start to the end of the study at weekly intervals is presented in Table 1. The highest body weight was found in Treatment 3 (LED color red) with a mean of 133.91 while the lowest was found under Treatment 4 (LED color blue) with a mean of 112.19. The study revealed that there are highly significant differences in all treatments from week 4 and 6 while there are no significant differences on week 1-3 and 5. During the experiment, reared quails under Treatment 3 (LED color red) gained weight faster and reached higher body weight than birds on the rest treatment. This indicates that the body weight of the quail's performance was affected by the different LED light color treatment on 4 and 6 while the rest of the growing period did not affect. It is also observed that the results of the body weight of quails were affected by the conditions of the environment every time that the week has good weather they gained more weight.

The results of this study are in agreement with the recent findings of Soliman, A.S. *et al*. (2023) [32], they found that there are some significant differences in some weeks and there are also no significant differences in body weight. They stated that birds raised under LED lighting had significantly heavier BW compared to those raised under Inc lighting. They conclude that birds raised under LED lighting had significantly heavier BW at different ages of breeding (brooding, rearing, and production) compared to those raised under Inc lighting.

Table 2: Average body weight of bird in grams

Treatment means, in week							
WEEK	**T1**	**T2**	**T3**	**T4**	**F Value**	**Pr (>F)**	**CV%**
1	13.10	13.60	13.90	13.00	0.47	0.7089^{ns}	9.17
2	33.15	31.27	26.53	30.67	2.42	0.1330^{ns}	11.79
3	51.23	53.42	55.75	47.17	2.18	0.1600^{ns}	9.53
4	84.37^{a}	81.64^{a}	85.38^{a}	71.43^{b}	7.23	0.0090^{**}	5.88
5	82.52	98.81	101.32	86.01	1.06	0.4115^{ns}	19.54
6	133.61^{a}	132.60^{a}	133.91^{a}	112.19^{a}	8.60	0.0052^{**}	5.65
Grand Mean	**66.33**	**68.56**	**69.47**	**60.08**			

ns not significant
*** highly significant*
T1- LED yellow light (control)
T2- LED green light
T3- LED red light
T4- LED blue light

Feed Consumption

Feed Consumption refers to the quantity of feed that the quail consumes. The amount of food consumed affects bone growth, eggshell quality, reproductive processes, and body weight gain.

Table 2 shows the feed consumption of the Japanese quails. Treatment 3 (LED color red) had the highest feed consumption of 76.97g, while Treatment 4 (LED color blue) had the lowest feed consumption of 45.91g. The experimental birds consumed approximately the same amount of feeds of full-fed quails at the final week of the experiment. The data shows that there are significant differences in week 1 and 4 highly while on week 3, 5, and 6 shows highly significant differences of the experiment, however, week 2 shows no significant difference. This indicates that the feed consumption of the quail's performance was affected by the different LED light color treatments. On week 3, 5, and 6 it shows highly significance since it has the lowest p-value among the weeks.

According to the study by Shaista, S. *et al*. (2018) [31] effect of different light sources on the performance of broiler chickens reared under a deep litter system of management, found significant differences in the feed consumption and feed conversion ratio of the birds with lower feed consumption and a better feed conversion ratio in LED light. In quail production, it was reported by Radi, M., et. al. (2020) [27] that LED colors had an influence on feed efficiency. Their study on the effect of different monochromatic LED light colors and intensities on growth performance, physiological responses, and fear reactions in broiler chickens. The results on growth performance state that there was a significant effect of light color on feed intake and feed consumption ratio with the birds reared under the GL × BL that recorded the lowest feed intake and feed consumption ratio, followed by BL, GL, and WL. Furthermore, Fidan, E.D. *et al*. (2023) [9] stated that LED light color affects feed intake of quails from 0 to 42 days of age. Their study revealed that FI suppressed the green LED light group compared to white and blue LED light at 0-42d.

During the period of conduct, there were several observations that may have been the reason behind these results. The mortality due to the transportation of quail on the first day causes stress, and the constant changes in weather affect their feeding. In week 1 and 2, there has been mortality among the quail, while the following weeks are consistent, and that is how feed consumption is affected.

Table 3: Average feed consumption per bird in grams

Treatment means, in week							
WEEK	**T1**	**T2**	**T3**	**T4**	**F Value**	**Pr (>F)**	**CV%**
1	33.36^{a}	33.21^{ab}	33.85^{a}	32.40^{b}	4.74	0.0301^{*}	1.74
2	39.43	42.81	42.67	43.83	0.74	0.5544^{ns}	10.52
3	48.29^{b}	55.82^{ab}	67.34^{a}	45.17^{b}	7.44	0.0083^{**}	13.35
4	53.61^{bc}	59.11^{ab}	69.24^{a}	45.19^{c}	6.41	0.0130^{*}	14.02
5	58.93^{b}	59.28^{b}	70.9^{a}	47.39^{c}	8.15	0.0062^{**}	11.38
6	55.41^{bc}	62.67^{b}	76.97^{a}	45.91^{c}	11.45	0.0020^{**}	12.85
Grand Mean	**48.17**	**52.15**	**60.16**	**43.32**			

ns not significant
**significant*
*** highly significant*
T1- LED yellow light (control)
T2- LED green light
T3- LED red light
T4- LED blue light

Feed Efficiency/Feed Conversion Ratio

Feed Efficiency or Feed Conversion Ratio (FCR) is a ratio that indicates how well livestock bodies transform animal feed into the intended product. To calculate the feed conversion ratio, take the total feed weight and divide it by net production (ending weight minus starting weight).

The feed conversion ratio that was observed in the growing quails during the experimental period is presented in Table 3. In week 6 there is a high significant difference, Treatment 3 (LED color red) had the highest feed efficiency with a mean of 2.37, while Treatment 4 (LED color blue) in the same week had the lowest feed efficiency with a mean of 1.75. The study revealed that week 4 and 6 resulted in significant differences and weeks 1, 2, 3, and 5 had no significant differences through the feed efficiency of the quail during the experiment. This implies that the treatments with different LED lights color influenced the feed efficiency of the quails only on the finishing stage.

Furthermore, Al, A.Z. *et al*. (2015) [1] stated that they found no difference in feed conversion and carcass yield across treatments in their study, effect of different LED light colors on development of the reproductive system of quails. However, the current findings are countered by Soliman A.S.'s observation. *et al*. (2023) [32], who found that variations in feed conversion ratio values across all examined week intervals are extremely significant.

Table 4: Feed efficiency/Feed conversion ratio per bird in grams

Treatment means, in week							
WEEK	**T1**	**T2**	**T3**	**T4**	**F Value**	**Pr (>F)**	**CV%**
1	5.86	5.25	5.16	5.84	0.36	0.7832^{ns}	22.54
2	1.97	2.52	3.62	1.92	3.05	0.0851^{ns}	36.16
3	2.93	2.54	1.76	2.74	1.76	0.2240^{ns}	31.14
4	1.64^{b}	2.09^{ab}	2.35^{a}	1.84^{b}	4.49	0.0345^{*}	14.65
5	3.13	3.48	4.62	3.29	3.04	0.0851^{ns}	21.26
6	1.88^{b}	1.85^{b}	2.37^{a}	1.75^{b}	6.76	0.0111^{*}	10.80
Grand Mean	**2.90**	**2.96**	**3.31**	**2.90**			

ns not significant
**significant*
T1- LED yellow light (control)
T2- LED green light
T3- LED red light
T4- LED blue light

Average Weekly Gain

Average weight gain refers to the increases in body weight during the whole week. The average weekly gain was estimated in grams by subtracting the individual initial live weight from the final live weight in a certain week.

Table 4 shows the average weekly gain of the experimental birds from weeks 1-6. The results showed significant differences in average weekly gain values during the 3rd, 4th and 6th weeks, while there were no significant differences during the 1st, 2nd, and 5th weeks. The results revealed that Treatment 2 on week 6 had the highest mean average weekly gain of 33.79g, while the lowest average weekly gain mean was 26.18g obtained in Treatment 4. This implies that the 3rd, 4th, and 6th only significantly influenced the AWG of the quails but did not significantly affect the AWG on the rest of the growing period.

Moreover, the results of this study are found to be similar to a recent study by Soliman, A.S. *et al*. (2023) [32] on the effect of different lighting sources on the performance of broiler breeder hens. The results of their study showed significant differences in weekly body weight gain values during the 25th week of age, while there were no significant differences at all other studied rearing weeks. Their birds raised under LED lighting had significantly higher Weekly Body Weight Gain (13.31%) during the 25th week of age compared to those raised under Inc lighting. In this study, there are some significant differences, but there are also no significant differences in rearing weeks of quail average weekly gain.

Table 5: Average weekly gain of quails

Treatment means, in week							
WEEK	**T1**	**T2**	**T3**	**T4**	**F Value**	**Pr (>F)**	**CV%**
1	5.85	6.50	6.69	6.02	0.41	0.7519^{ns}	19.64
2	20.04	17.67	12.63	18.17	2.18	0.1602^{ns}	25.05
3	18.08^{b}	22.15^{ab}	29.22^{a}	16.49^{b}	4.56	0.0332^{*}	24.77
4	33.14^{a}	28.21^{bc}	29.63^{ab}	24.26^{c}	8.57	0.0053^{**}	8.71
5	19.68	17.18	15.93	14.58	2.17	0.1612^{ns}	17.47
6	29.57^{bc}	33.79^{a}	32.60^{ab}	26.18^{c}	10.03	0.0031^{**}	7.04
Grand Mean	**21.06**	**20.92**	**21.12**	**17.62**			

ns not significant
**significant*
*** highly significant*
T1- LED yellow light (control)
T2- LED green light
T3- LED red light
T4- LED blue light

Mortality

Mortality refers to the number of deaths in a given population per unit of time, scaled to that population's size, and is known as the mortality rate or death rate.

Table 5 shows the mortality rate in the experimental birds from weeks 1–3, implying that all week results are not significant. It revealed that in Week 2, Treatment 3 (LED color red) had the highest mortality rate of 2.75, while the lowest mortality rate was in Week 3, Treatment 1 (LED color yellow) was 0.75.

During the rearing period, there were fifty-seven (57) mortalities found in the cage. All of the purchased chicks were in good condition, but due to transportation from farm to experimental area, some chicks died from stress. Mostly from week 1 to week 3, the rate of mortality is high since they are all sensitive at this age. From the 4-6 weeks, there was no mortality encountered.

Table 6: Average mortality of quail weekly

Treatment means, in week							
WEEK	**T1**	**T2**	**T3**	**T4**	**F Value**	**Pr (>F)**	**CV%**
1	2.00	1.75	1.50	2.00	0.26	0.8554^{ns}	52.22
2	0.50	1.50	2.75	1.50	3.04	0.0855^{ns}	67.67
3	0.75	0.00	0.00	0.00	2.45	0.1298^{ns}	255.31
Grand Mean	**1.08**	**1.08**	**1.42**	**1.17**			

ns not significant
T1- LED yellow light (control)
T2- LED green light
T3- LED red light
T4- LED blue light

Conclusions

Based on the findings stated above the following conclusion were made. For the growth performance, the different treatment which is LED light colors can influence the body weight, feed consumption, feed efficiency, and average weekly gain. Moreover, the mortality shows no significant difference throughout the whole week. The results show that

Treatment 3 (LED color red) gives the best performance in body weight, while Treatment 2 (LED color green) in average weekly gain, and Treatment 4 (LED color blue) in feed consumption and efficiency.

Recommendations

In view of the above-stated summary of findings and conclusions, the following are the recommendation made in this study:

1. The farmers may use LED lights for growing birds. It is also stated in the other studies that it is a great factor that influences body weight, feed intake, feed conversion ratio, and average weekly gain.
2. Quail performance improves, especially on feed consumption. This study has proved efficient in improving this parameter. Farmers may use blue or yellow LED lights for the growth performance because they show the lowest feed consumption. For good performance on average weekly gain, it is recommended to use green LED lights while red light on body weight.

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