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The Effect of Light Color and Lighting Length on Ovarium Size and Follicles Amount of Laying Quail (*Coturnix-coturnix japonica*)

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Abstract— *This research is to determine the color effect of light and duration of irradiation on the size of the ovaries and the number of follicles of laying female quail. This research will be conducted from march 1 – May 11, 2022. The location of the research is in Hamlet 1 Kemit, Kwaren, Ngawen District, Klaten Regency, Central Java. This research was conducted for 72 days with the maintenance of quail aged two weeks - 10 weeks with a total of 189 tails. The experimental design used was a Completely Randomized Design (CRD) with a 3 x 3 factorial pattern analyzed using Analysis of Variance (ANOVA). If there were differences, further testing was carried out with the Duncan New Multiple Range Test (DMRT). The treatments were P0: control color, P1: red, P2: blue, R0: 14 hours of irradiation, R1: 18 hours of irradiation and R2: 22 hours of irradiation. The variables observed consisted of oviduct length, ovarium weight, amount of follicles, egg production, and age of sexual maturity. The results showed a significant interaction between giving different light colors to the number of follicles of laying quail. It was concluded that blue light with irradiation of 22 hours resulted in the highest egg production and efficiency.*

Keywords— *Laying Quail, Light Color, Lighting length, Ovarium, Folicel.*

I. INTRODUCTION

Increasing public awareness of the importance of consuming quality nutrition will cause the demand for protein foods of animal origin to increase. Quail is a poultry that has a small body size, grain eaters and small insects. The type of quail that is often cultivated in Indonesia is Japanese quail (Coturnix-coturnix japonica). Quail is a livestock that produces eggs and meat. Quail has the potential to be developed as a productive business, not a few breeders cultivate it with a closed house cage system.

In the closed house system, in addition to easily controlling air circulation and temperature, closed house cages are also able to minimize livestock stress. The closed house cage gets its overall illumination from the lights provided. Lighting is one of the factors affecting the development and production of livestock, including quail.

The period of layers in poultry is greatly influenced by the lighting program given. One of the relationships between light and livestock is determined by the color of the light and the duration of irradiation given. The lighting received by poultry can serve to stimulate the development of the reproductive system and locomotor activity of poultry so that food and water intake becomes higher (Blatchford et al., 2012). Light can help livestock in the process of vision, make it easier to find food, drinks and facilitate poultry reproductive activities. The light given to livestock serves to stimulate the internal cycle and stimulate the release of hormones.

Light with different colors or wavelengths, has a varying effect when the retina of the eye receives which results in changes in behavior patterns in quail that can affect their growth and development. Further research Mardiati et al., (2010) stated that giving blue light causes aves to calm down so that it stimulates growth and can reduce stress responses, red light can increase consumption rates in livestock, reduce cannibalism, accelerate feather and wing growth and spur sexual adulthood, followed by yellow and green light will stimulate muscle growth. In another study conducted by Negara et al., (2013) explained that the length of irradiation can affect livestock activities. Cattle that were given 4 hours of exposure differed in activity levels from those that were exposed for 12 hours. Light plays a role in the mechanism of the avian hormonal system that will enter through the retinal photoreceptors and be received by the hypothalamus, then will control the secretion and release of Gonadotropin Relasing Hormone (GnRH) will then be transpoted to the pituitary. GnRH can stimulate Folicle Stimulating Hormone (FSH) and Luteinizing Hormone (LH) as sexual hormones. Sexual hormones can function to stimulate the development and maturation of follicles in the ovaries.

The study aims to determine the effect of giving light color and duration of irradiation on the size of the ovaries and the number of follicles of laying female quails, to determine the interaction between light color and the length of irradiation on the size of the ovaries and the number of follicles of laying female quails and to determine the efficiency of giving different light colors and the duration of irradiation on the size of the ovaries and the number of follicles of laying female quail.

II. RESEARCH MATERIALS AND METHODS

This research will be conducted from March 1 – May 11, 2022. The location of the research is in Hamlet 1 Kemit, Kwaren, Ngawen District, Klaten Regency, Central Java.

Research Materials

The materials used included 189 female quails, commercial feed for broiler quails, and laying quails from PT. New Hope

Indonesia, at starter age, is given feed New Hope NB101B, while during the layer phase, it is given feed New Hope SQ101 of 50kg. Vitamin egg stimulant.

The tools used in this study included stationery, laying quail cages, places to feed and drink quail, 1-watt red, blue, and incandescent LED lights, 50kg digital scales, timers, scalpels, and trays.

Research Methods

The research method is an experimental method on female quail in the layer phase. Quail were reared for two weeks in rearing cages and four weeks in layer cages.

a) During the study, quail were fed ad libitum by giving 300 g at 08.00 WIB and then given drinking ad libitum using a nipple. Vitamins are given every day by mixing through drinking water.
b) Egg collection was carried out at 09.00 WIB by weighing the weight of the eggs and counting the number of eggs produced from each column.
c) The test light sources are arranged in series in each cage. The series of lights are equipped with a timer (timer) to adjust the on and off of the lights.
d) The cages used in the study were flat model cages made of wood, strimin wire, and sacks. The cage is 1 meter long, 45 cm wide, and 25 cm high, with a floor slope of 5 cm. The number of cages used was three cages, and each cage had nine columns with a capacity of 7 quails in each column.

Data Retrieval Method

The research data was obtained from the treatment given, namely (P0) warm/incandescent, (P1) red, and (P2) blue, and then given the long exposure time treatment including (R0) 14 hours, (R1) 18 hours and (R2) 22 hours. There are 27 experimental box units.

The observed variables include:

a) Measuring the Reproductive Canal Length
Reproductive canal length data were obtained from measurements carried out on 72 days during the slaughter process using a ruler with a scale of 0 - 30cm.

b) Weighing the Ovaries
Ovarian weight data were collected at the age of 72 days after the slaughter process was carried out. Weighing is carried out using a digital analytical balance.

c) Counting the Number of Follicles
The number of follicles that have been done at the age of 72 days is calculated by knowing the number of follicles that can develop and do not develop after necropsy.

d) Calculating Egg Production
Egg production data is known by weighing and summing the total eggs produced every day while the livestock is in the layer cages. Egg production is calculated (% Quail day production) based on the formula (Sudrajat et al., 2014):

$$QDP = \frac{total\ egg\ production\ (items)}{quail\ quantity} x100\ \%$$

e) Age of First Egg Laying (sexual maturity)
Data on the age of sexual maturity was obtained by recording the cattle that laid eggs first at 42 days of age. Age of sexual maturity is indicated by the number of eggs produced by quail workers at the first laying of more than 5% of the total quail population.

Data analysis

The experimental design used was a Completely Randomized Design (CRD) with a 3 x 3 factorial pattern analyzed using Analysis of Variance (ANOVA). If there were differences, further testing was carried out with the Duncan New Multiple Range Test (DMRT).

III. Results and Discussion

The Effect of Light on the Reproductive System

Reproductive Tract Length

This research was conducted to determine the effect of the color of the light associated with the wavelength and duration of irradiation on the length of the reproductive tract of laying female quails. Complete data can be seen in Table 1.

TABLE 1. Average Reproductive Canal Length (Cm)

Light Color	Lighting Length			Average*
	R0	R1	R2	
P0	30	29	28	29
	29	29.4	28.2	28.87
	31	30.2	28	29.73
Average	30^{b}	29.53^{b}	28.07^{b}	29.2
P1	30	38.3	29.9	32.73
	29.3	33.2	29	30.5
	29	30	29	29.33
Average	29.43^{bc}	33.83^{a}	29.3^{b}	30.86
P2	27.2	25.8	28	27
	26.5	25	27	26.17
	26.9	24.5	28.1	26.5
Average	26.87^{cd}	25.1^{d}	27.7^{bc}	26.56
$Average^{s}$	28.77	29.49	28.36	28.87*

Explanation :
ns = non significant,
* = real interaction
different alphabetical superscripts on one line showed a significant difference (P < 0.05).

Based on the results of the research that has been done, Table 1 shows that from the treatment of giving light color and duration of lighting, there is an interaction between giving light color and duration of irradiation which differs on the length of the oviduct (reproductive canal) in laying female quails aged nine weeks. Red light and irradiation time of 18 hours (P1R1) produced an oviduct length of 33.83cm, significantly different from P1R0 29.43cm and (P1R2) 29.30cm. These results can be due to the secretion of reproductive hormones such as Luteinizing Hormone (LH) and Follicle Stimulating Hormone (FSH) from Gonadotropin-Releasing Hormone (GnRH) in the anterior pituitary, which causes interactions between P1R1. FSH will stimulate the development and growth of follicles. The growth of the egg follicle will stimulate the secretion of estrogen to spur the growth of the reproductive tract. According to Primary et al. (2020), one that can affect the length of the oviduct is an increase in estrogen concentration which can stimulate the functional development of the oviduct channel.

The color treatment of incandescent or control light with an irradiation time of 14 hours (P0R0) 30cm had no significantly different results from P0R1 29.53cm, P0R2 28.07cm, and P2R2 27.70cm, while P2R0 26.87cm was not significantly different from P2R1 25.10cm. These results are the same as research according to Manurung et al. (2013), that the length of the oviduct illuminated by an incandescent lamp for 12 hours is around 29.68cm. Control light has a lower wavelength than red light. However, higher than blue light, so the light control color has the ability to penetrate the hypothalamus faster than blue light due to different wavelengths. According to Li et al. (2015), the control LED light has a wavelength of 580nm, while the blue light is 480nm.

Red light can also increase consumption in livestock and reduce cannibalism which is common in quails. This is supported by Miftah's research (2022) which showed the result that giving red color could increase quail consumption higher than other colors, namely 22.28 g/head/day. This is because red wavelengths can more quickly activate the hunger center in the lateral hypothalamus. High consumption makes reserves of secretions in livestock also more.

Secretions in the reproductive tract are released in the form of protein and calcium needed for the formation of eggs. Stimulation of good estrogen levels can induce the synthesis of ovalbumin, conalbumin, ovomucin, and lysozyme in the oviduct during egg formation and vitellogenin in the liver (Delsy et al., 2016). The process of releasing GnRH from the hypothalamus is also induced by the protein for gene from neuronal activation. The expression of the fos protein gene in the hypothalamic mediobasal will increase when the transfer occurs for 18 hours (Kasiyati, 2009).

Fos gene activity in the hypothalamus is a sign that the aves hypothalamus receives sufficient light information transmission so that GnRH secretion occurs. According to Sukriyah (2020), in dark conditions, the enzymes Hydroxyindole – O - methyl Transferase (HIOMT) and N-Acetyl Transferase (NAT) increase, causing high melatonin levels. High melatonin levels will inhibit the release of the hormone GnRH from the hypothalamus, and the release of FSH and LH from the anterior pituitary is also inhibited, so puberty is also inhibited. Conversely, in bright conditions, melatonin levels decrease. According to Kasiyati (2009), the secretion of LH and FSH, which plays a role when melatonin is reduced, is also controlled by GnIH (gonadotrophin inhibitory hormone).

Ovarian Weight and Follicle Count

This research was conducted to determine the effect of the color of the light associated with the wavelength and duration of irradiation on the weight of the ovaries of laying female quails. Complete data can be seen in Table 2.

The results in table 2 show that there is an interaction between the color of the light and the different duration of irradiation on the weight of the ovary of the laying female quail. Red light and irradiation time of 18 hours (P1R1) 7.02g resulted in significantly different ovarian weights with P0R0 4.41g, P2R0 4.71g, P2R2 5.30g, P1R0 6.37g and P2R1 6.40g and P1R2 5.45g, but not significantly different with P0R1 6.57 g, P1R2 6.68g.

TABLE 2. Average Ovary Weight (g)

Light Color	Lighting Length			Average*
	R0	R1	R2	
P0	4.25	6.30	5.10	5.22
	4.00	6.67	5.24	5.31
	4.98	6.763	6.00	5.91
Average	4.41[d]	6.57[ab]	5.45[c]	5.48
P1	6.53	6.93	6.67	6.71
	6.60	6.94	6.70	6.74
	6.00	7.20	6.71	6.63
Average	6.37[b]	7.02[a]	6.68[ab]	6.69
P2	4.63	6.10	5.33	5.35
	5.00	6.52	5.37	5.63
	4.50	6.59	5.20	5.43
Average	4.71[d]	6.40[b]	5.30[c]	5.47
Average*	6.16	6.67	5.80	5.88

Explanation :
ns = non significant,
* = real interaction
different alphabetical superscripts on one line showed a significant difference (P < 0.05).

TABLE 3. Amount of follicles

Light Color	Lighting Length			Average*
	R0	R1	R2	
P0	13	20	16	16.33
	12	22	15	20.33
	13	18	15	18.33
Average	12[e]	20[b]	15[de]	14.67
P1	17	27	16	20
	18	25	18	20.33
	16	20	19	18.33
Average	17[bc]	24[a]	17[bc]	19.56
P2	12	12	15	13
	12	14	11	12.33
	14	15	16	15
Average	12[e]	13[de]	14[de]	13.44
Average*	14.05	17.89	15.72	15.89

Explanation :
ns = non significant,
* = real interaction
different alphabetical superscripts on one line showed a significant difference (P < 0.05).

Based on the results of the research that has been done, Table 3 shows no significant interaction with light color and duration of irradiation in 9-week-old female quail laying eggs. Treatment with red light for 18 hours (P1R1) had significantly different results of 24 points compared to 17 points for P1R0 and P1R2. P0R1 20 items had significantly different results from P0R0 12 items and P0R2 15 items. The 12-item P2R0 treatment had no significant results when compared to the 13-point P2R1 and 14-point P2R2.

The weight of the ovaries in female livestock is influenced by the number of ova present in the ovaries. The more developed and mature the ovum in livestock, the heavier the ovary will be. Ovarian weight is used to determine reproductive maturity in experimental female quails (Sukriyah, 2020). Follicular development is closely related to the number of eggs that will be produced by livestock. Follicles that can develop normally will produce eggs continuously until the expulsion period arrives. The results of Tables 2 and 3 can be assumed that the high red wavelength (700-740nm) and sufficient

Setyo Utomo, Defi Zahra, Nur Rasminati, and Ajat Sudrajat, "The Effect of Light Color and Lighting Length on Ovarium Size and Follicles Amount of Laying Quail (*Coturnix-coturnix japonica*)," *International Research Journal of Advanced Engineering and Science*, Volume 9, Issue 2, pp. 84-89, 2024.

duration of irradiation (18 hours) make cattle grow faster in the process of growth and maturation of follicles due to FSH secretion, which causes an increase in estrogen. The faster the maturation of the follicles, the higher the secretion of LH to an increase in progesterone; then, this will continue for the cattle to enter sexual maturity. A red light will be received by the retina of the bird and will be channeled to the hypothalamus to secrete GnRH, then GnRH will stimulate the secretion of the hormones FSH, LH, estrogen, and progesterone, these hormones will be responsible for stimulating egg production and increasing fertility (Putra, 2013). The anterior pituitary will secrete FSH and increase the hormone estrogen, so that follicle growth, development, and maturation occur. At the same time, the ovaries will stimulate LH to secrete progesterone so that ovulation can occur. According to Densely et al. (2016), sexual maturity (sexual maturity) can affect the condition of the ovaries and can be manipulated by giving a specific light color, especially for the red light wavelength.

Most of the mature follicles were produced by the red treatment, while the immature ovum was produced mostly by the blue treatment. According to Miftah, 2022 Treatment with red light with a long irradiation time of 18 hours resulted in a higher feed consumption value compared to giving red for 14 and 22 hours, and also higher than giving control and blue light with the same irradiation duration. When viewed from the consumption value factor, it can be assumed that the treatment of red light makes the absorption of the feed consumed into nutrients to help ripen the follicles, while the blue light absorbs nutrients from the feed to help the process of forming a new ovum. According to Setyawan (2006), egg production can be determined by ovum production, and the factors that affect ovum production are the environment which can affect the hormonal system, and the amount of feed consumed.

The response from red light was also stated by Mardiati et al. (2010). Giving red light with sufficient irradiation can increase consumption rates in livestock, accelerate the growth of feathers and wings and, stimulate sexual maturity, affect livestock activities such as eating, drinking and reproducing. The blue light response with a shorter wavelength (480nm) makes livestock calmer so that the nutrients consumed are focused on reproductive growth and development. The less irradiation is given, the less activity livestock can do. Because according to research by Blatchford et al. (2012) light can help cattle in their locomotor activities.

Egg Production

This research was conducted to determine the effect of the color of the light associated with the wavelength and duration of irradiation on the egg production of laying female quails. Complete data can be seen in Table 4.

Based on the results of the research that has been done, table 4 shows that giving different light colors and irradiation times has no interaction with egg production. Treatment of blue light and 22 hours of irradiation (P2R2) resulted in the highest percentage of egg production at 76.03% compared to other treatments. The results of this study are better than those of Kasiyati (2009), that egg production exposed to red light in quail aged 5-9 weeks has an egg production of 72.72%, and according to Tryanto (2007), egg production in quail aged 5-9 week which was given light with the duration of the irradiation for 22 hours of 67.47%. Quail egg production standards, according to Sangi et al. (2017), at the age of 6 weeks, the average is 69.65% to 71.98%. According to Miftah (2022), the blue light treatment with a 22-hour irradiation duration had the lowest feed consumption value of 18.16g/head/day and the lowest feed conversion of 2.86.

TABLE 4. Egg Production (%)

Light Color	Lighting Length			Average^{s}
	R0	R1	R2	
P0	67.74	71.42	70.04	
	73.27	70.50	72.35	
	77.88	67.74	75.57	
Average	72.96	69.89	72.65	71.83
P1	54.37	71.42	73.27	
	78.80	72.35	72.35	
	69.58	78.80	70.04	
Average	67.58	74.19	71.88	71.22
P2	73.73	71.42	73.27	
	74.65	71.88	85.71	
	58.06	69.12	69.12	
Average	68.81	70.81	76.03	71.88
Average^{ns}	69.79	71.63	73.52	71.65

Explanation :
ns = non significant,
* = real interaction
different alphabetical superscripts on one line showed a significant difference (P < 0.05).

The amount of egg production during the study was included in the good results because, under ten weeks of age, the egg production rate can reach 77-79%. According to Suleman's research (2018) peak, quail egg production reached 77.81% - 90.71% at 13 weeks of age. This shows that giving blue color can make the waves calm, and the nutrition received can be optimal in egg production. According to Miftah (2022), blue light produces the lowest conversion among other colors. While high production at 22 hours of irradiation due to the need for sufficient light in the formation of hormones. According to Tryanto (2007), providing light for 24 hours resulted in lower egg production than that given irradiation for 22 hours. This was due to excess hormone formation; livestock became overactive and expended more energy. In addition, the quail's lack of rest has an impact on setting the quail's stress.

Gender Maturity Age

This research was conducted to determine the effect of the color of the light associated with the wavelength and duration of irradiation on the sexual maturity of laying female quails. Complete data can be seen in Table 5.

Based on the results of research that has been carried out according to Table 6 regarding the Age of Sexual Maturity, it shows that the provision of light with different colors and duration of irradiation shows no significant interaction results on the age of first laying quail eggs. Treatment with red light and 18 hours of irradiation (P1R1) resulted in the age of the first egg laying earlier on the 42nd day of the rearing period, and the results showed the same age as previous studies. According to

Setyo Utomo, Defi Zahra, Nur Rasminati, and Ajat Sudrajat, "The Effect of Light Color and Lighting Length on Ovarium Size and Follicles Amount of Laying Quail (*Coturnix-coturnix japonica*)," *International Research Journal of Advanced Engineering and Science*, Volume 9, Issue 2, pp. 84-89, 2024.

Kasiyati (2009), the age of first laying eggs for quail given red light is at the age of 41-43 days, and giving red light can produce sexual maturity faster than giving blue light and controls. Red light has a longer wavelength, so it can penetrate the quail skull, which will then be received by the hypothalamus to release GnRH. GnRH will affect the pituitary to release FSH and LH. These two hormones function to stimulate the development and maturation of follicles in the ovaries, which is commonly called sexual maturity. This is in accordance with Hassan et al. (2013). Light with long wavelengths penetrates the skin tissue and bones of the aves skull more easily so that it can stimulate the pituitary gland to secrete hormones that control reproduction.

TABLE 5. Gender Maturity Age (Day)

Light Color	Lighting Length			Average^{s}
	R0	R1	R2	
P0	42	43	43	42.67
	43	44	44	43.67
	45	43	43	43.67
Average	43.33	43.33	43.33	43.33
P1	47	43	44	44.67
	42	43	43	42.67
	42	42	43	42.33
Average	43.67	42.67	42.67	43.33
P2	44	46	43	44.33
	43	42	44	43
	45	46	45	45.33
Average	44	44	44.5	44.16
Average^{s}	43.67	43.67	43.72	43.54

Explanation :
ns = non significant,
* = real interaction
different alphabetical superscripts on one line showed a significant difference ($P < 0.05$).

Irradiation with a length of 18 hours produces the fastest sexual maturity because the light is sufficient to help estrogen in maturation. Sexual maturity is strongly influenced by day length (length of light). According to Densely et al. (2016), The presence of GnRH in the anterior pituitary will stimulate the release of Follicle Stimulating Hormone (FSH) and Luteinizing Hormone (LH) hormones which are involved in the sexual maturation of poultry. FSH will stimulate the development and maturation of follicles. Follicle development will stimulate estrogen secretion to stimulate growth in the oviduct. The development of growing follicles will eventually trigger the secretion of progesterone in the pituitary to be able to secrete LH. High levels of progesterone and LH will trigger the process of ovulation or sexual maturity for the first ovulation. According to Kasiyati (2009) the FSH that has been secreted will be received by the ovaries and help the ovum follicles to grow and develop. Follicle development continues to stimulate the secretion of estrogen. The presence of estrogen will initiate growth and development of the oviduct, pubic bone development, mobilization of nutrients, absorption of vitamins, synthesis of albumin, and absorption of bone calcium. Follicles that have developed and are large in size will trigger the secretion of progesterone. When the flow of progesterone and LH reaches its highest concentration, it will spur the ovulation process.

IV. CONCLUSION

Based on the results of this study, it can be concluded as follows:
1. There is an effect of giving the color of light and the duration of irradiation on the size of the ovaries and the number of follicles in the laying female quail.
2. There is an interaction between the color of the light and the duration of irradiation on the size of the ovaries and the number of follicles in the laying female quail.
3. Blue light color with 22 hours of irradiation time is the most efficient treatment to use because it has high production yields and high feed efficiency.

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Setyo Utomo, Defi Zahra, Nur Rasminati, and Ajat Sudrajat, "The Effect of Light Color and Lighting Length on Ovarium Size and Follicles Amount of Laying Quail (*Coturnix-coturnix japonica*)," *International Research Journal of Advanced Engineering and Science*, Volume 9, Issue 2, pp. 84-89, 2024.

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