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A SYSTEMATIC REVIEW ON THE DEVELOPMENT OF QUAIL OVARY EMBRYOGENESIS (*Coturnix coturnix Japonica*) UNDER DIFFERENT LIGHTING COLORS

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ABSTRACT: **Quail (*Coturnix coturnix Japonica*) is one of the commercial poultry that is being developed and produced more frequently. Various lighting programs (pre-hatching) on Aves have been carried out to provide an increased biological response, including growth, reproduction, and productivity. The addition of light or the lighting program is also a factor in the growth of Aves which directly plays a role in controlling various physiological processes. The purpose of this study was to review embryogenesis development of the Quail ovary under various lighting conditions. A literature search was carried out systematically through the PubMed, NCBI, and Google Scholar databases using keywords, namely, "embryogenesis development, ovary, quail light color, and lighting". The articles obtained were selected based on these keywords by setting several inclusion criteria. Papers that do not meet the inclusion criteria are eliminated, and articles that meet the criteria will be analyzed to obtain data. Based on the search results in the databases using predetermined keywords, 500 articles were obtained. All articles were selected based on inclusion criteria and exclusion and obtained as many as 35 articles that met the inclusion criteria. From the results of the research, it can be concluded that giving variations in the colour of lighting for 16 hours affects the development of quail ovaries. Because of the significant effect of lighting and its colour on embryo development, pre-hatch lighting programs should be considered in future studies.**

Keywords: Egg, Embryogenesis, Incubation, Lighting, Quail.

INTRODUCTION

Quail (*Coturnix coturnix Japonica*) is one of the poultry species that is being developed and increased in commercial production. Apart from meat, quails are egg producers with high productivity, producing between 200 and 300 eggs per head per year (Akarikiya, 2021). The nutritional value of quail eggs is not inferior to other poultry, such as hens (Wilson, 2017). One of the new approaches in this field is providing a lighting program in quail farms. Various lighting programs on Aves have been carried out to increase biological response such as growth, reproduction, and productivity (Yameen et al., 2020; Gharaoghlan et al., 2022).

The age of sexual maturity in female quails is characterised by the first time they lay eggs, while for males it is characterised by the start of crowing with a distinctive sound. Quails first lay eggs between 35-72 days old with an average age of 41. This was also expressed by another research which showed that quails reach sexual maturity on average at the age of six weeks, but it is also found that they are older than that age (El-Sayed et al., 2022; Wiradimadja et al., 2007). This situation caused by health factors, management, and food also affects sexual maturity. Other factors that have an impact are genetics, lighting, and body weight. The growth of Aves, which is directly responsible for controlling various physiological processes, is also influenced by the addition of light or the lighting program (Drozdová et al., 2021; Franco et al., 2022).

Several studies demonstrated that exposing fertile eggs to light can increase the growth of the embryo and decrease the incubation period. Post-hatch artificial lighting is an important management method for the growth and muscle development of meat-type birds. Embryo exposure to light leads to changes in metabolic rate, such as an increase in embryo metabolic rate in the pigeon (*Columba livia domestica*) light compared with darkness. Furthermore, exposure to light increased the heart rate of embryos. Providing light during broiler egg incubation affects production, health, and exhibits the potential to reduce the stress associated with growth and production. Archer G in 2017 reported that providing light for 12 h/day during egg incubation reduced susceptibility to the stress of broilers post-hatch (Abdulateef et al., 2021). The physiological mechanism of light stimulating embryonic growth and development differs before and after

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the formation and maturation of the retinal photoreceptor. The hypothalamic pacemaker and pineal gland are the main parts of the circadian avian system. Embryonic cell proliferation increases with high light intensity. Experimental work in domesticated species of birds showed that light accelerates embryonic development by increasing metabolic activity and increased embryonic development, pineal gland formation, and modifies melatonin synthesis (Yalcin et al., 2022).

Low light intensity (e.g. 10 lx) can entrain embryonic starlings Sturnus valgus to show a light-dark rhythm mediated by high melatonin hormone concentrations in darkness and low levels during light exposure, which is a universal feature of embryonic organisms. The research demonstrated that chicken embryos exposed to light for as little as 1 h decrease melatonin production and affects embryonic development (Kankova et al., 2022).

The light energy that comes from artificial light with a light source will produce light with a single wavelength frequency that is directly related to the color of the light. Each color will have a different effect on behavior, growth, and reproduction (Xie et al., 2008). Another research showed that quail in relation to the color of light showed that blue light causes quails to calm down thereby stimulating growth and reducing the stress response, further, red light can reduce cannibalism, stimulate the growth of wing feathers, and stimulate sexual maturity, furthermore, green light stimulate muscle growth in adolescence and increase antibody production (Abeysinghe, 2019). In addition, the red color also causes quail to be more aggressive in pecking feed. The purpose of this study was to analysis of embryogenesis development of the quail ovary given different lighting color.

METHODS

A literature search was carried out systematically through the PubMed, NCBI, Google Scholar databases using keywords, namely "Development of Embryogenesis, Ovary, Quail (*Coturnix coturnix Japonica*) Light Color, and Lighting". Based on these keywords, the articles obtained were first selected by setting several inclusion criteria including journals are not paid / free articles, research results focus on "Development of Embryogenesis, Ovary, Quail (*Coturnix coturnix Japonica*) Light Color, and Lighting." Articles that do not meet the inclusion criteria are eliminated and articles that meet the criteria will be analyzed to obtain data.

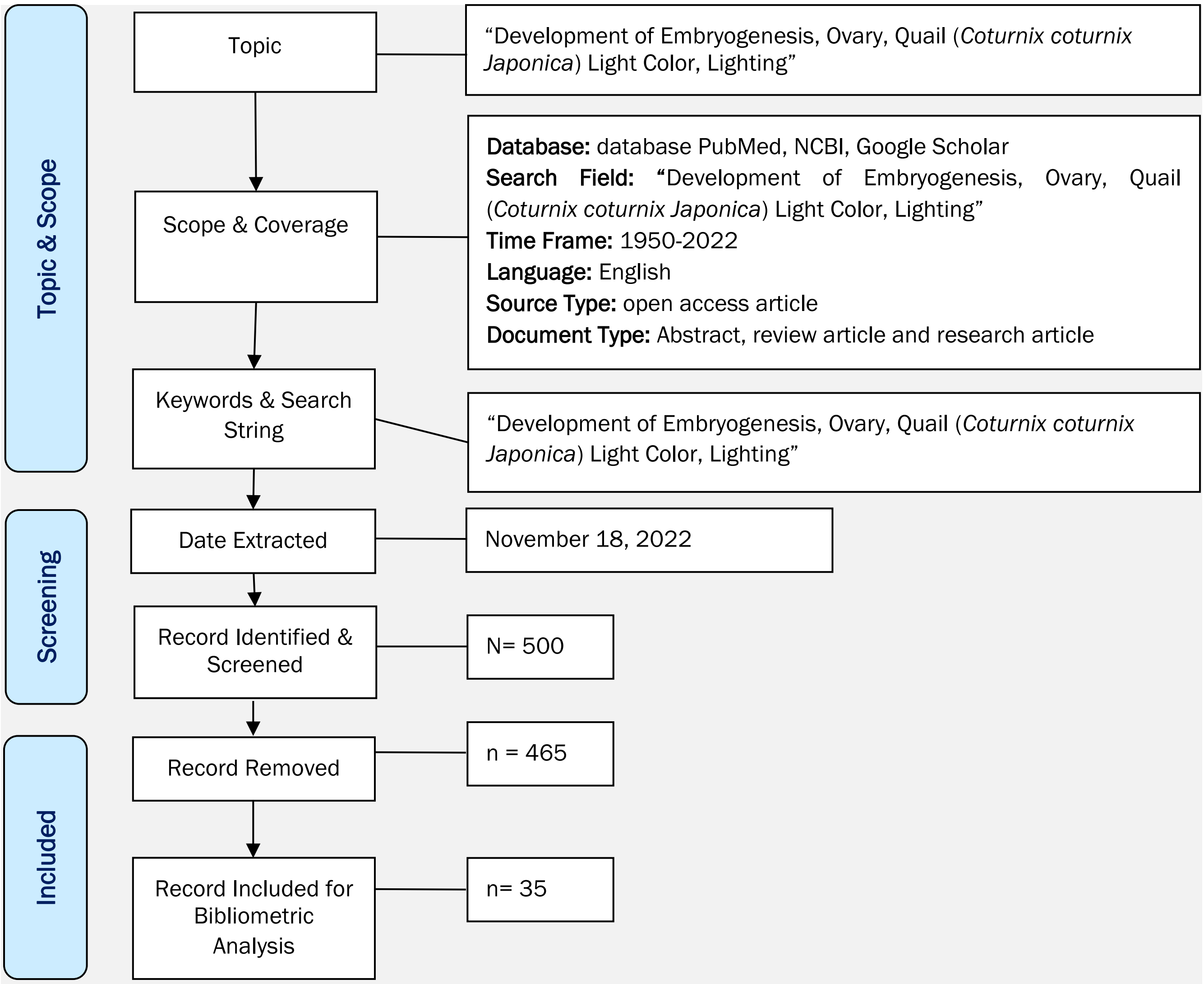

Figure 1 - Flow diagram of search strategy

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RESULTS

Based on the search results in the PubMed, NCBI, Google Scholar databases using predetermined keywords, 500 articles were obtained for the development of embryogenesis, ovary, quail (*Coturnix coturnix Japonica*) light color, lighting. All articles were re-selected based on inclusion criteria and exclusion and obtained as many as 35 articles that meet the inclusion criteria. Figure 1 explains the structure of the ovary based on the treatment group, namely, the control group (K), clear lighting (I), red lighting (II) blue lighting (III), yellow lighting (IV). In the 2nd treatment group (blue lighting) the quail ovarian structure was better than the 3rd treatment group. In Table 1, the ovarian weight of the quail was obtained; the treatment group 2 obtained a better ovarian weight compared to the three treatment groups.

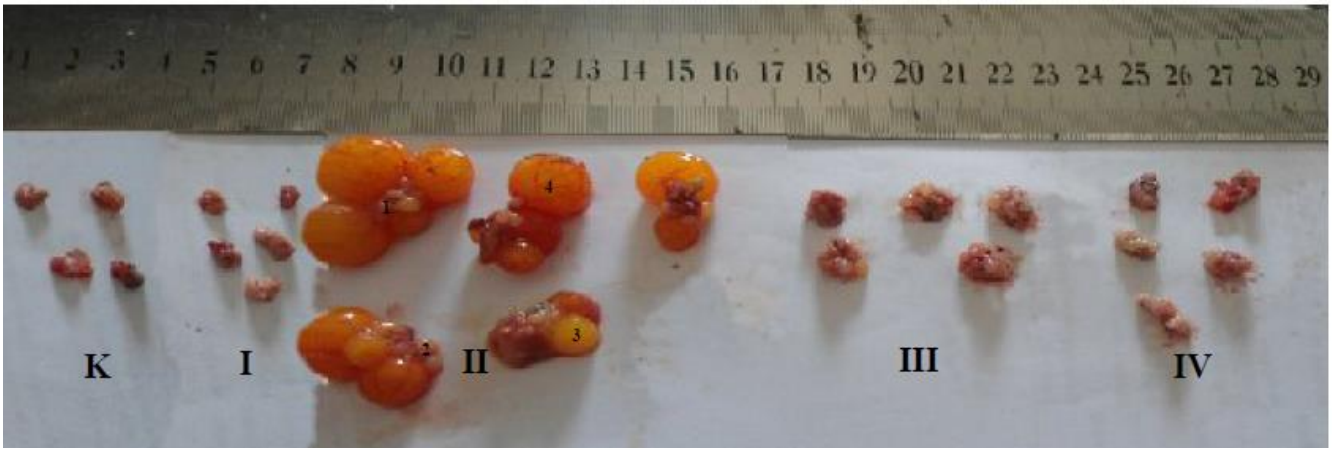

Figure 1 - The structure of the quail ovary in the control group (K). clear lighting (I), red lighting (II) blue lighting (III), yellow lighting (IV). 1 primary follicle, 2 secondary follicles, 3 tertiary follicles, 4 Graff follicles (El-Sayed et al., 2022).

Table 1 - Weight of quail ovaries given 16 hours of light color variations at 6 weeks of age.

Group	Mean ± SEM
Control	0.06 ± 0.02[a]
I	0.12 ± 0.05[ab]
II	3.46 ± 2.71[c]
III	0.26 ± 0.06[abd]
IV	0.15 ± 0.03[abde]

Different letters indicate significant differences at P<0.05. I= clear lighting, II=red lighting, III=blue lighting, IV=yellow lighting.

DISCUSSION

The light received by the eye will be brought to extraretinal receptors in the hypothalamus (Mishra et al., 2018). These nerve impulses are transmitted to the hypothalamic suprachiasmatic nucleus via the retinohypothalamic fibres, then proceed to the hypothalamic paraventricular nucleus. Impulses will be forwarded to the spinal cord and pass through the adrenergic preganglionic fibres of the sympathetic nervous system. Through the sympathetic nerves, impulses will reach the pineal gland (the centre of biological clock regulation). This causes the release of norepinephrine (NE) so that through the AMP cycle it will increase the production of tryptophan hydroxylase which plays a role in serotonin synthesis. Serotonin has no direct effect on the reproductive process (Gu et al., 2022).

Serotonin is a building block for melatonin. In dark conditions the activity of Hydroxyindole-O-methyltransferase (HIOMT) increases resulting in the conversion of serotonin to melatonin. However, in bright conditions, melatonin decreases so that it can release the Gonadotropin-releasing hormone (GnRH) from the hypothalamus. Stimulation of the hypothalamus can lead to the development of the reproductive system of quails, which will stimulate the acceleration of sexual maturity marked by the development of follicles. Based on the observation of the macroscopic appearance of quail ovaries, shows that ovarian development in the control group is less than optimal. This can be seen from the weight of the ovaries which has the lowest average compared to the other groups. Lack of light causes stimulation of the release of GnRH from the hypothalamus to experience obstacles. An obstructed hypothalamus will find it difficult to stimulate reproductive hormones, such as Follicle-stimulating hormone (FSH) and Luteinizing hormone (LH). As research said that the lack of light signals causes GnRH to be unable to secrete FSH and LH. Low light causes the HIOMT enzyme to convert serotonin into melatonin. Because low light causes high melatonin, thereby inhibiting the release of the GnRH hormone. This is what causes the development of quail ovaries to be less than optimal (Sharokhyan Rezaee et al., 2022).

One of the researcher reported that if a lighting program of 12 hours of light/a day has no effect on accelerating the maturation of quail ovarian follicles, that would be due to the ovarian follicles not yet developed (Stein, 1974). Then,

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another research added that when quail were given a short period (8 hours of light and 16 hours of darkness) and then maintained normal (12 hours of light and 12 hours of darkness), the concentration of LH in their blood plasma did not change so that giving light for 12 hours was not effective in increasing the concentration of LH in quail (Follett et al., 1977). Quail ovaries in group I that used clear color lighting showed that the ovaries had formed grape-like protrusions.

However, the development of the ovary has not yet reached the Graff follicle, it is still only a hierarchy of follicles. This is almost the same as the control group. However, what distinguishes it is the provision of light, which is for 16 hours. As stated by another researcher which said that providing light for 16 hours/day can provide better productivity and performance than providing light for 12 hours/day (Vanderzwalmen et al., 2003). Based on the observation of the macroscopic appearance of the quail ovaries, it shows that the red color has the most optimal ovarian development compared to the other groups. In addition, red light has the longest wavelength compared to the others, so it has a strong intensity to affect the hypothalamus.

The retina of quails is very sensitive to red lighting. Before receiving red light from the retinal photoreceptors, it must first pass through the ocular media, namely the cornea, aqueous humour, lens, and vitreous humour, so that light is not directly transmitted to the hypothalamus. However, it will go through a series of reactions from light energy to be converted into electrochemical signals (phototransduction). These electrochemical impulses are then sent to the hypothalamus. This statement was reinforced when stated that the red light (700 nm) received by quails will stimulate the hypothalamus to secrete GnRH, which in the next stage the presence of GnRH will stimulate the secretion of reproductive hormones, such as FSH, LH, estrogen, and progesterone which in turn will stimulate egg production and increase fertility (Akyüz and Onbaşilar, 2018). In accordance with what was stated by Onagbesan and Peddie (1988) and Asem et al., (1985) the presence of GnRH will be responded to by the pituitary to secrete FSH and LH (Asem et al., 1985; Onagbesan and Peddie, 1988). The flow of FSH received by the ovary causes the ovary follicles to grow and develop.

Increased development of quail ovaries that get red light requires sufficient energy as a result, quail consume more feed. Lewis et al. (2001) also suggested that the entry of light information into the pineal gland will stimulate the synthesis, release, and metabolism of dopamine (Lewis et al., 2001). The presence of dopamine causes birds to become more active and easily stimulated. Various daily activities require energy both obtained from feed nutrients and from energy reserves stored in the body. Whereas in group III (lighting with blue light), the development of quail ovaries had better development than in the control group, the group I, and group IV. This happens because lighting blue lights makes quail calmer and controlled feed intake. As an argue which stated giving blue to birds can cause birds to become calmer (Akyüz and Onbaşilar, 2018).

In addition, Mardiati stated that blue light which has a short wavelength (450 nm) is able to penetrate directly and be absorbed by the skull bones and cranial tissue which are then received by extraretinal photoreceptors. This causes sexual maturity to turn blue faster than the control group, I and IV. Foster and Soni (1998) and Daghir (2008) stated that extraretinal photoreceptors in the Aves are scattered in the basal part of the brain, lateral septum, hypothalamus (deep brain), intracranial pineal organ, and cerebrospinal fluid connected to neurons. Photoreceptors are nerve cells that are specialized to receive light signals and transduce these light signals into electrochemical signals. Brain tissue is permeable to light and light absorbed by brain tissue will be filtered back by neural tissue, but most of the light with short wavelengths such as blue light will still be able to penetrate the base of the brain. The light signal received by the hypothalamus will stimulate the release of GnRH.

The development of the ovary in blue light occurs through a process proposed by Lewis, and Moris that the Aves hypothalamus is very sensitive to blue light (Akyüz and Onbaşilar, 2018). A blue light will also be received by a quarter of the total number of rod cells in the retina of the avian eye (Lewis and Morris, 2000). The blue light signal received by the rod cells will be directly received by the hypothalamus via the optic fibres. The blue color of the development of the ovaries is not as good as the red color because the red color can be received by the cone cells in Aves, while the blue color cannot be received by the cone cells. As for the yellow light color, in group IV the development of the quail ovarian follicles did not reach the mature follicles. In this group have follicles that begin to develop. This is because the yellow color causes the quail to consume food not as aggressively as the group using red light. This statement is reinforced by the opinion of North and Bell in Madzingira who said that the yellow color can reduce the aggressiveness of quail towards feed, so that the development of the ovaries will decrease (Madzingira, 2018). This statement is reinforced by the research in 1992 which concluded that increasing feed restrictions will result in more pressure on egg production, which is caused by the low energy consumption required for egg production (Olawuni et al., 1992).

The low energy consumption found in group IV makes it difficult for light to stimulate the hypothalamus to secrete GnRH. The difficulty of stimulating the hypothalamus against GnRH causes reproductive hormones, especially FSH and LH, to be unable to be stimulated. This is what causes quail ovaries to not develop properly. As stated by Olanrewaju et al. (2006) states that the speed of cooking quail genitals requires an adequate source of energy from feed intake.

CONCLUSION

From the results of research conducted, it can be concluded that giving variations in the color of lighting for 16 hours affects the development of quail (*Coturnix coturnix Japonica*) ovaries. Pre-hatch lighting program should be considered in future studies.

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DECLARATIONS

We declare that this research work is original and has not been published.

Author's contribution

Maslichah was conducted the supervision, funding acquisition, project administration, writing the draft manuscript, while Akhmad did revision of manuscript. Jonathan analyzed for result and method.

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Conflict of interests

This study has no conflict of interest

REFERENCES

Abdulateef SM, Al-Bayar MA, Majid AA, Shawkat SS, Tatar A, and Al-Ani MQ (2021). Effect of exposure to different light colors on embryonic development and neurophysiological traits in the chick embryo. Veterinary World, 14(5): 1284-1289. https://doi.org/10.14202/vetworld.2021.1284-1289

Abeysinghe KWGNDK (2019). Adaptation to the pullet-rearing environment by providing lighting during embryo development. Dalhousie University. http://hdl.handle.net/10222/76391

Akarikiya SA (2021). Quail production systems, prospects and constraints in ghana. University of Development Studies, Ghana. http://udsspace.uds.edu.gh/bitstream/123456789/3256/1/QUAIL%20PRODUCTION%20SYSTEMS%2C%20PROSPECTS%20CONSTRAINTS%20IN%20GHANA.pdf

Akyüz HÇ, and Onbaşilar EE (2018). Light wavelength on different poultry species. World's Poultry Science Journal, 74(1): 79–88. https://doi.org/10.1017/S0043933917001076

Asem E, Marrone BL, and Hertelendy F (1985). Steroidogenesis in ovarian cells of the Japanese quail (Coturnix coturnix japonica). General and Comparative Endocrinology, 60(3): 353–360. https://doi.org/10.1016/0016-6480(85)90068-1

Daghir NJ (2008). Poultry production in hot climates. Cabi Publication, UK. https://www.cabidigitallibrary.org/doi/book/10.1079/9781845932589.0000

Drozdová A, Kaňková Z, Bilčík B, Zeman M (2021). Prenatal effects of red and blue light on physiological and behavioural parameters of broiler chickens. Czech Journal of Animal Science, 66(10):412-419. https://cjas.agriculturejournals.cz/pdfs/cjs/2021/10/03.pdf

El-Sayed MA, Hatab MH, Ibrahim NS, Assi HAEM, Saleh HM, Sayed WAA and et al. (2022). Comparative Study Of Growth And HSP70 Gene Expression In Japanese Quails Fed Different Levels Of Black Solder Fly, Hermetia Illucens. Researchsquare: 1-13. https://doi.org/10.21203/rs.3.rs-2289928/v1

Follett BK, Davies DT, and Gledhill B (1977). Photoperiodic control of reproduction in Japanese quail: changes in gonadotrophin secretion on the first day of induction and their pharmacological blockade. Journal of Endocrinology, 74(3): 449–460. https://doi.org/10.1677/joe.0.0740449

Foster RG, and Soni BG (1998). Extraretinal photoreceptors and their regulation of temporal physiology. Reviews of Reproduction, 3:145–150. https://doi.org/10.1530/ror.0.0030145

Franco BR, Shynkaruk T, Crowe T, Fancher B, French N, Gillingham S, et al. (2022). Light color and the commercial broiler: effect on behavior, fear, and stress. Poultry Science, 101(11): 102052. https://doi.org/10.1016/j.psj.2022.102052

Gharaoghlan MF, Bagherzadeh-Kasmani F, Mehri M, and Ghazaghi M (2022). The effect of short, long, natural, and intermittent short photoperiods on meat-type Japanese quails. International Journal of Biometeorology, 66(9): 1737–1745. https://doi.org/10.1007/s00484-022-02314-1

Gu J, Guo M, Yin X, Huang C, Qian L, Zhou L, et al. (2022). A systematic comparison of neurotoxicity of bisphenol A and its derivatives in zebrafish. Science of The Total Environment, 805:150-210. https://doi.org/10.1016/j.scitotenv.2021.150210

Kankova Z, Drozdova A, Hodova V, and Zeman M (2022). Effect of blue and red monochromatic light during incubation on the early post-embryonic development of immune responses in broiler chicken. British Poultry Science, 63(4): 541-547. https://doi.org/10.1080/00071668.2022.2042485

Lewis PD, and Morris TR (2000). Poultry and coloured light. World's Poultry Science Journal, 56(3):189-207. https://www.cambridge.org/core/journals/world-s-poultry-science-journal/article/abs/poultry-and-coloured-light/F01E7E2974854A9D00D01B0AE3132173

Lewis PD, Perry GC, Morris TR, and English J (2001). Supplementary dim light differentially influences sexual maturity, oviposition time, and melatonin rhythms in pullets. Poultry Science, 80(12): 1723–1728. https://doi.org/10.1093/ps/80.12.1723

Madzingira O (2018). Animal welfare considerations in food-producing animals. Animal Welfare, 99. pp 171-179. https://doi.org/10.5772/intechopen.78223

Mishra I, Agarwal N, Rani S, and Kumar V (2018). Scotostimulation of reproductive neural pathways and gonadal maturation are not correlated with hypothalamic expression of deiodinases in subtropical spotted munia. Journal of Neuroendocrinology, 30(9): e12627. https://doi.org/10.1111/jne.12627

Olawuni KA, Ubosi CO and Alaku SO (1992). Effects of feed restriction on egg production and egg quality of exotic chickens during their second year of production in a Sudano-Sahelian environment. Animal Feed Science and Technology, 38(1): 1–9. https://doi.org/10.1016/0377-8401(92)90071-D

Onagbesan OM and Peddie MJ (1988). Steroid secretion by ovarian cells of the Japanese quail (Coturnix coturnix japonica). General and Comparative Endocrinology, 72(2): 272–281. https://doi.org/10.1016/0016-6480(88)90210-9.

Sharokhyan Rezaee M, Farzinpour A, Farshad A, and Hatfaludi T (2022). The regulative effect of Urtica dioica on sex hormones imbalance: elevated follicle-stimulating hormone/luteinizing hormone ratio≥ 4.5 is associated with low performance in aged breeder quails. Italian Journal of Animal Science, 21(1): 142–152. https://doi.org/10.1080/1828051X.2021.2007801

Stein GS (1974). Control of Ovarian Maturation in the Japanese Quail (Coturnix Coturnix Japonica). The Ohio State University. https://www.semanticscholar.org/paper/Control-of-ovarian-maturation-in-the-Japanese-quail-Stein/8e4476c65a5df7f1da9e66daf748722422527dba

Vanderzwalmen P, Bertin G, Debauche CH, Standaert V, Bollen N, Roosendaal E, et al (2003). Vitrification of human blastocysts with the Hemi-Straw carrier: application of assisted hatching after thawing. Human Reproduction, 18(7): 1504–1511. https://doi.org/10.1093/humrep/deg298.

Wilson PB (2017). Recent advances in avian egg science: A review. Poultry Science, 96(10): 3747–3754. https://doi.org/10.3382/ps/pex187

Wiradimadja R, Piliang WG, Suhartono MT, and Manalu W (2007). Age Maturity of female japanese quails fed diets containing katuk leave meal (*Sauropus androgynus* L. Merr. Animal Production, 9(2): 187-198. https://www.animalproduction.net/index.php/JAP/article/view/157

Xie D, Wang ZX, Dong YL, Cao J, Wang JF, Chen JL, and et al. (2008). Effects of monochromatic light on immune response of broilers. Poultry Science, 87(8): 1535–1539. https://doi.org/10.3382/ps.2007-00317.

Yalcin S, Özkan S, and Shah T (2022). Incubation Temperature and Lighting: Effect on Embryonic Development, Post-Hatch Growth, and Adaptive Response. Frontiers in Physiology, 873: 18-29. https://doi.org/10.3389/fphys.2022.899977.

Yameen RM, Hussain J, and Mahmud A (2020). Effects of different light durations during incubation on hatching, subsequent growth, welfare, and meat quality traits among three broiler strains. Tropical Animal Health and Production, 52(6):3639-3653. https://doi.org/10.1007/s11250-020-02401-8

Citation: Mafruchati M, Makuwira J and Wardhana AK (2023). A systematic review on the development of quail ovary embryogenesis (*Coturnix coturnix Japonica*) under different lighting colors. *Online J. Anim. Feed Res*., 13(1): 63-68. DOI: https://dx.doi.org/10.51227/ojafr.2023.10