PHOTOPERIOD EFFECT ON GROWTH, REPRODUCTIVE TRAITS, HORMONAL AND THERMO-PHYSIOLOGICAL RESPONSE OF THE PEARL GUINEA FOWLS †

[EFECTO DEL FOTOPERÍODO SOBRE EL CRECIMIENTO, RASGOS REPRODUCTIVOS, RESPUESTA HORMONAL Y TERMOFISIOLÓGICA DE LAS GALLINAS DE GUINEA]

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SUMMARY

Background. Guinea fowl production is gaining much attention and recognition across the globe. However, the bird's inability to lay fertile eggs all year round is one of the key challenges to commercialization and intensive production. **Objectives/hypothesis.** This study examines the photoperiod effect on growth, reproductive traits, hormonal and thermo-physiological response of the Pearl Guinea fowls. This study hypothesize that photoperiod will solve the seasonal breeding behaviour among Guinea fowls. **Methodology.** This study was conducted at Dawu in the Ashanti Region of Ghana. Birds used for this investigation were subjected to different photoperiod: 12HL:12HD, 14HL:10HD, 16HL: 8HD and 18HL:6HD using a white bright LED Energy saving bulbs of 120 watts with light intensity of 5.60 lux and kept from day-old to 168 days in a completely randomized design. **Results.** Birds subjected to 18HL:6HD treatment group recorded the highest ($P < 0.05$) final body weight (1757.23 g/bird), body weight gain (1734.33 g/bird), daily weight gain (10.32 g/bird), total feed intake (6627.3 g/bird) and daily feed intake (39.45 g/bird). Birds subjected to 14HL:10HD had the best (3.809) feed conversion ratio. Birds subjected to 18HL:6HD laid earlier ($P < 0.05$) (130 days) with the lowest ($P < 0.05$) egg weight of 23.33 g. While birds subjected to 12HL:12HD reached 184 days before starting egg production ($P < 0.05$) but recorded the highest ($P < 0.05$) egg weight of 37.33 g. Birds in the 18HL:6HD treatment group recorded the highest ($P < 0.05$) percentage fertility (86.94) followed by 16HL:8HD (79.86 %) and 14HL:10HD (79.44 %). Hatchability was very high among birds subjected to 16HL:8HD and 18HL:6HD with mean values of 82.89 % and 82.69 % respectively. FSH, LH, Prolactin and testosterone levels in the blood increased with increasing photoperiod ($P < 0.05$). Birds on the 18HL:6HD treatment had the highest ($P < 0.05$) body temperature (41.57 ºC), pulse rate (270.87 Beats/min), respiratory rate (42.69 Breath/min) and rectal temperature (42.95 ºC). **Implications.** Except for birds subjected to 12HL:12HD, birds across the other photoperiod groups were able to lay fertile eggs across the period of study. **Conclusion.** This study concludes that, photoperiod levels up to 18HL: 6HD promote rapid growth, reduce age at first egg laying, improve fertility and hatchability of Guinea fowl eggs and boost hormonal production.

Key words: Photoperiod; growth; reproductive traits; hormones; thermo-physiological response.

RESUMEN

Antecedentes. La producción de gallinas de Guinea está ganando mucha atención y reconocimiento en todo el mundo. Sin embargo, la incapacidad del ave para poner huevos fértiles durante todo el año es uno de los principales desafíos para su comercialización y producción intensiva. **Objetivos/hipótesis**. Este estudio examina el efecto fotoperíodo sobre el crecimiento, los rasgos reproductivos, la respuesta hormonal y termofisiológica de las gallinas de Guinea. Este estudio plantea la hipótesis de que el fotoperíodo resolverá el comportamiento reproductivo

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estacional entre las gallinas de Guinea. **Metodología.** Este estudio se realizó en Dawu en la región de Ashanti de Ghana. Las aves utilizadas para esta investigación fueron sometidas a diferentes fotoperíodos: 12HL:12HD, 14HL:10HD, 16HL:8HD y 18HL:6HD utilizando un LED blanco brillante. Focos ahorradores de energía de 120 vatios con una intensidad de luz de 5.60 lux y mantenidas desde el día de edad hasta 168 días en un diseño completamente al azar. **Resultados**. Las aves sometidas al grupo de tratamiento 18HL:6HD registraron el mayor ($P < 0.05$) peso corporal final (1757.23 g/ave), ganancia de peso corporal (1734.33 g/ave), ganancia de peso diaria (10.32 g/ave), consumo total de alimento (6627.3 g/ave) y el consumo diario de alimento (39.45 g/ave). Las aves sometidas a 14HL:10HD tuvieron la mejor tasa de conversión alimenticia (3.809). Las aves sometidas a 18HL:6HD pusieron antes ($P < 0.05$) (130 días) con el peso de huevo más bajo ($P < 0.05$) de 23.33 g. Mientras que las aves sometidas a 12HL:12HD alcanzaron significativamente ($P < 0.05$) 184 días antes de comenzar la producción de huevos, pero registraron el mayor peso de huevo ($P < 0.05$) de 37.33 g. Las aves en el grupo de tratamiento 18HL:6HD registraron el porcentaje de fertilidad más alto ($P < 0.05$) (86.94), seguido de 16HL:8HD (79.86 %) y 14HL:10HD (79.44 %). La incubabilidad fue muy alta entre las aves sometidas a 16HL:8HD y 18HL:6HD con valores medios de 82.89 % y 82.69 % respectivamente. Los niveles de FSH, LH, prolactina y testosterona en la sangre aumentaron ($P < 0.05$) al aumentar el fotoperiodo. Las aves en el tratamiento 18HL:6HD tuvieron la temperatura corporal (41.57 °C), la frecuencia del pulso (270.87 latidos/min), la frecuencia respiratoria (42.69 respiraciones/min) y la temperatura rectal (42,95 °C) más altas ($P < 0.05$). **Implicaciones**. Con la excepción de las aves sometidas a 12HL:12HD, las aves de los otros grupos de fotoperíodo pudieron poner huevos fértiles durante el período de estudio. **Conclusión.** Este estudio concluye que niveles fotoperíodo de hasta 18HL: 6HD promueven un crecimiento rápido, reducen la edad de la primera puesta de huevos, mejoran la fertilidad y la incubabilidad de los huevos de gallina de Guinea y aumentan la producción hormonal.
Palabras clave. Fotoperíodo; crecimiento; rasgos reproductivos; hormonas; respuesta termo-fisiológica.

INTRODUCTION

Guinea fowl farming serves as an economic lifeline for many Ghanaian farmers, particularly those living in rural areas (Kyere *et al.,* 2025). The birds are a valuable source of income through the sale of meat, eggs and live birds. Guinea fowl meat is considered a nutritious option for all age categories of people. It is lean and rich in protein, with a distinctive flavor that appeals to consumers, offering a potential market for Guinea fowl producers. Guinea fowl farming in Ghana often involves a mix of traditional and modern farming practices, and productivity can vary among different regions and individual farms (Okyere *et al.*, 2020). To improve productivity in terms of egg laying and meat quality, many farmers in Ghana seek training and support from agricultural extension services and government programs aimed at promoting poultry farming. Additionally, collaboration with local and international agricultural organizations helps Ghanaian farmers' access resources and expertise to enhance their Guinea fowl farming practices and productivity (Kyere *et al.,* 2025, Okyere *et al.,* 2020). Guinea fowls are hardy birds that can adapt to various environmental conditions (Kyere *et al*., 2025).

The birds require relatively low inputs compared to other poultry species, making the birds accessible to a wide range of farmers across the country. The bird is very popular especially in the Northern parts of Ghana with maximum demand for meat and eggs. Unfortunately, the performance of the bird in Ghana and other African continents is very abysmal due to several factors such as photoperiod, seasonal breeding behaviour, poor feeding, egg size (Kyere *et al.,* 2025), pathogenic infections and scarcity of feed during the dry season (Okyere *et al*., 2020). Guinea fowls most often lay in the rainy season and cease laying during the dry season (Kyere *et al.,* 2025, Okyere *et al.*, 2020). Hence, the birds are popularly referred to as seasonal breeders (Kyere *et al.,* 2025). The bird's inability to lay all year round is one of the key challenging factors to commercialization and intensive keeping of the bird in many African countries of which Ghana is not exception (Okyere *et al.* 2020). This situation has called for extensive research to delve into the physiological factors responsible for the seasonal breeding behaviour of Guinea fowls and ensures that the birds lay eggs throughout the year.

Physiologically, the seasonality of laying in Guinea fowls is as a result of the combined effect between photoperiod and inward circannual rhythms (Gosomji *et al.,* 2024, Kuenzel *et al.,* 2015). In the laying season, the hypothalamic-pituitary-gonadal axis sparks to activate the release of more LH and FSH which promote egg laying (Gosomji *et al.,* 2024, Wu *et al.,* 2022). LH plays a major role in Leydig cells' production of testosterone which are responsible for germinal cell development during spermatogenesis and the release of the egg. Dry season is noted to affect the production of Leydig cells leading to poor egg formation and laying (Gosomji *et al.,* 2024). FSH also plays a major role in follicular growth and development leading to continuous egg laying. Studies conducted by Wu *et al.* (2022), De-Oliveira and Lara (2016) showed that manipulation of light at different regimes for broilers influences feed and water intake with higher feed conversion efficiency. Hajrasouliha and Kaplan (2012) also reported that light supplementation to broiler chickens modulates systematic immune responses, reduces physiological aggressive behaviours, and improves health and welfare (Riber, 2015). Melatonin belongs to the group of indoleamine and is a natural compound that regulates physiological activities day and night. Melatonin functions as a photoperiod signal which influences cellular growth, follicular growth and development in hens and regulates testosterone secretion and proliferation of different testicular cells (Hao *et al.,* 2020, Gonzalez-Arto *et al.,* 2016).

Artificial light in poultry production is used to manipulate growth and physiological activities in birds' reproduction. Several studies conducted in broilers and Guinea fowls have proven that light has a great impact on egg formation, laying and cock reproductive organs (Abdul-Rahman *et al.* 2016, Dharani *et al.,* 2018, Baso *et al.,* 2023). However, studies on the biological manipulation of light to tackle the issue of seasonal breeding behaviour in Guinea fowls are very scanty. Therefore, this research was designed to investigate the growth and reproductive performance, hormonal and thermo-physiological response of the Pearl Guinea fowls subjected to different lighting regimes in Ghana. This study hypothesizes that Guinea fowl hens will respond well to different light regimes to bring about massive changes in growth performance and hormones responsible for egg laying and change the seasonal breeding behaviour in Guinea fowls.

MATERIALS AND METHODS

Information on Research location

This study was conducted at Dawu in the Ashanti Region of Ghana, between the period of 27th June, 2023 and 12th December, 2023 and lasted for 168 days. Dawu is located in the Sekyere South District and situated on the Kumasi-Ejura road in the Ashanti Region of Ghana. Dawu is 293 meters elevation above sea level in the transitional zone characterized by abundant tropical rain forest and well known for its poultry farming activities in the Ashanti Region. The coordinates of the town are 6°43'60" N and 1°31'60" W in degrees minutes seconds (DMS). The latitudes and longitude of the area are 07^{o} 04' and 01^{o} 24' degrees respectively. The average minimum and maximum temperatures recorded during the study period were 20.89 ^{o}C and 30.4 ^{o}C respectively. The town experiences a bimodal rainfall pattern between April-July and August-November and also experiences a dry season which occurs between December-March.

Experimental animals, design and treatments

A total of 120 day-one-old pearl Guinea fowls were randomly selected and put in four different lighting treatment groups. Each treatment was replicated 3 times with ten birds per replicate in a completely randomized design. The treatment groups were: 12HL:12HD, 14HL:10HD, 16HL: 8HD, and 18HL:6HD using white bright LED Energy saving bulbs and rechargeable lamps containing 120 watts with a combined mean of 5.60 lux light intensity (The European Commission, 2000). Where HL: Hours of light and HD: Hours of darkness.

Experimental diets

A single diet was formulated and used for feeding the experimental birds (Table 1). Feed and clean water were made available at all times without restrictions. Health management practices were strictly followed at all stages of growth. The various compositions at the starter and grower phases are presented in Table 1. The nutrient levels met the NRC (1994) nutrient requirement for growing poultry.

Parameters measured

At day-old and 168 days of growth, the experimental birds were weighed to obtain their body weight. Weight gain was computed by subtracting the initial weight from the final body weight. Furthermore, daily weight gain was estimated by dividing the weight gain by the total number of days (168). Feed was given to the birds and feed leftovers were weighed and recorded. In computing the feed conversion ratio, feed consumed by the birds in each treatment was divided by the weight gain.

At 16 and 24 weeks of age, nine birds from each treatment group were randomly considered for blood collection and analysis. Blood from the experimental birds was collected early in the morning between 7 -8 a.m. from the brachial wing vein using a sterilized disposable syringe and needles. Methylated spirit was used for soaking the cotton and applied on the point where the needle piers through the vein to dilate the vein and prevent subsequent infections from the wound created by the needle. Two (2) ml blood sample was allowed to coagulate and used for the hormonal analysis. The plasma concentrations of follicle stimulating hormone (FSH), luteinizing hormone (LH), oestrogen, progesterone, prolactin and testosterone were determined using radioimmunoassay and radioimmunoassay kits manufactured by Shenzhen Mindray Bio-medical Electronics Company Limited, China. The detection limits for follicle stimulating hormone (FSH), luteinizing hormone (LH), oestrogen, progesterone, prolactin and testosterone were 100 and 200 mIU/mL. Each assay run included four internal and external qualitatively-controlled samples. The mean intra- and inter-assay CV of hormones were between 2% and 6%, respectively. The normal hormone level ranges specified by the respective kits were used as reference (Cao *et al*., 2008; Wang *et al*., 2019).

Body temperature, rectal temperature, respiratory rate and pulse rate were the major thermo-physiological traits considered in this study. The body temperature of the Guinea fowls was determined by inserting a digital thermometer manufactured by Hong Kong Digitmex Instrument Limited, China about an inch into the vent of the birds and waited for 30 seconds until the thermometer beeping reached a constant reading and the reading was recorded (Ijadunola *et al.,* 2020).

Rectal temperature was determined by using a digital thermometer manufactured by Hong Kong Digitmex Instrument Limited, China. The digital thermometer was inserted into the cloaca of the bird at a depth of 2 cm for 30 seconds and the reading was recorded. Respiratory rate was reported as the rate of flank movements per minute and was estimated as breaths/minute (Ijadunola *et al.,* 2020). Pulse rate was determined by placing a stethoscope on the thigh of the Guinea fowl to determine the rhythmic beats of the heart per minute (Ijadunola *et al.,* 2020).

Statistical analysis

GenStat version 11.1 was used to analyze all the data collected during the conduct of this study. The average treatment means were separated using the LSD programmed in the GenStat at a 5% significant probability level. Correlation analysis was carried out to determine the relationship between body temperature, rectal temperature, respiratory rate and pulse rate using IBM SPSS version 27.0 software (SPSS Inc., Chicago, IL, USA). The significant level was set at 5% probability level. Hence, *p*-values less than 0.05 ($P < 0.05$) were considered significant.

Table 1. **Feed ingredients and nutrient compositions**.

Feed ingredients	Starter (0-8 weeks)	Grower (9-16 weeks)	Breeder (17-24 weeks)
Maize	56.2	58.00	59.00
Wheat bran	7.00	13.20	18.50
Soya bean meal	16.00	14.50	11.00
Tuna fish meal	18.00	11.50	7.50
Oyster shell	0.70	0.70	2.00
Dicalcium phosphate	0.70	0.70	0.50
Vitamin premix	0.70	0.70	0.50
Common salt	0.70	0.70	0.50
Total	100	100	100
Nutrient compositions of the diets			
Ash, %	16.11	15.88	15.31
Crude protein, %	22.10	19.45	17.42
Crude fibre, %	3.37	3.78	4.00
Moisture, %	10.01	10.08	10.09
Ether extract, %	4.53	4.52	4.53
Dry matter, %	90.44	91.21	90.55
Metabolizable energy, kcal/kg	2789.50	2892.50	2982

Vitamins: A (8100 I.U); B2 (2.00 mg); B12 (5.10 mg); (D3 (1511 I.U); E (2.60 mg) and K (1.50 mg); Folic acid (0.52 mg); Nicotimic acid (8.11 mg); Calcium Panthotenate (2.11 mg); Choline Cloruro (49 mg); Trace elements: Cu (4.61 mg); Co (0.11 mg); Mg (49 mg); Se (0.12 mg); Antioxidant Butylated Hydroxytoluene (10.10 mg); Carrier; Calcium carbonate q.s.p (2.61 kg)

RESULTS

Photoperiod effect on growth performance

The growth performance results among Guinea fowls subjected to different lighting regimes (Table 2) at the start of the study were statistically similar (P >0.05) among all the photoperiod groups. Birds in the 18HL:6HD treatment group recorded the highest (P <0.05) final body weight (1757.23 g/bird), body weight gain (1734.33 g/bird), daily weight gain (10.32 g/bird), total feed intake (6627.3 g/bird) and daily feed intake (39.45 g/bird) (Table 2). While, birds in the 12H:12D treatment group recorded the lowest (P < 0.05) final body weight (1649.17 g/bird), body weight gain (1625.66 g/bird), daily weight gain (9.676 g/bird), total feed intake (6243.6 g/bird) and daily feed intake (37.16 g/bird) (Table 2). Birds on the 14HL:10HD and 16HL:8HD recorded the intermediate values for all traits measured except the feed conversion ratio. Birds subjected to 14HL:10HD and 16HL:8HD had the best (3.809) and the poorest (3.876) feed conversion ratio respectively (Table 2).

Photoperiod effect on reproductive traits

Birds subjected to 18HL:6HD laid earlier (P < 0.05) (130 days) with the lowest (P < 0.05) egg weight of 23.33 g. While birds subjected to 12HL:12HD significantly (P <0.05) reached 184 days before starting egg production but recorded the highest (P < 0.05) egg weight of 37.33 g (Table 3). The highest (P < 0.05) percentage fertility (86.94) was recorded among birds subjected to 18HL:6HD followed by 16HL:8HD (79.86 %) and 14HL:10HD (79.44 %). The best hatchability was observed among birds subjected to 16HL:8HD and 18HL:6HD with mean values of 82.89 % and 82.69 % respectively, followed by birds subjected to 14HL:10HD (73.41 %). In contrast, birds subjected to 12HL:12HD recorded the lowest (P < 0.05) percentage fertility and hatchability values of 65.42 and 63.12 respectively (Table 3).

Photoperiod effect on hormonal levels of the pearl Guinea fowls

FSH, LH and Prolactin levels in the blood during the grower phase significantly (P < 0.05) increased with increasing photoperiod (Table 4). Birds subjected to 18HL:6HD had the highest (P < 0.05) FSH (0.571 IU/mL), LH (1.727 IU/mL) and prolactin (14.76 ng/mL) levels and the lowest levels of FSH (0.307 IU/mL), LH (0.415 IU/mL) and prolactin (8.34 ng/mL) were observed among birds subjected to 12HL:12HD. Birds on the 14HL:110HD and 16HL:8HD were intermediate (Table 4). Again, oestrogen, progesterone and testosterone levels were similar (P > 0.05) across the treatment groups during the grower phase. At the reproductive stage (Breeder phase) FSH, LH and testosterone levels in the blood were significantly (P < 0.05) affected by photoperiod. However, oestrogen, progesterone and prolactin levels were not (P > 0.05) affected by photoperiod.

Table 2. Photoperiod effect on growth performance (g/bird).

Parameters	12HL:12HD	14HL:10HD	16HL:8HD	18HL:6HD	SEM	P=
Initial body weight	23.50	23.06	23.35	22.90	0.320	0.237
Final body weight	1649.17^{d}	1685.53^{c}	1719.53^{b}	1757.23^{a}	2.79	0.001
Body weight gain	1625.66^{d}	1662.47^{c}	1696.18^{b}	1734.33^{a}	2.769	0.001
Daily weight gain	9.676^{d}	9.895^{c}	10.096^{b}	10.32^{a}	0.016	0.001
Total feed intake	6243.6^{a}	6331.9^{c}	6574.0^{b}	6627.3^{a}	24.59	0.001
Daily feed intake	37.16^{b}	37.69^{b}	39.13^{a}	39.45^{a}	0.146	0.001
Feed conversion ratio	3.841^{b}	3.809^{d}	3.876^{a}	3.822^{c}	0.018	0.003

[abcd] Means with different superscripts in the same row are significantly (p<0.05) different, HL= Hours of light, HD = Hours of light, SEM = Standard error of mean, P = Probability of main effect

Table 3. Photoperiod effect on reproductive traits.

Reproductive traits	12HL:12HD	14HL:10HD	16HL:8HD	18HL:6HD	SEM	P=
Age at first egg (Days)	184.0^{a}	180.0^{b}	143.0^{c}	130.0^{d}	3.40	0.001
Egg weight at first egg (Days)	37.33^{a}	36.00^{a}	30.00^{b}	23.33^{c}	1.986	0.001
Fertility (%)	65.42^{c}	79.44^{b}	79.86^{b}	86.94^{a}	0.653	0.001
Hatchability (%)	63.12^{c}	73.41^{b}	82.89^{a}	82.69^{a}	1.34	0.001

[abcd] Means with different superscripts in the same row are significantly (P <0.05) different, HL= Hours of light, HD = Hours of light, SEM = Standard error of mean, P = Probability of main effect

Table 4. Photoperiod effect on hormonal levels.

Hormonal Traits	12HL:12HD	14HL:10HD	16HL:8HD	18HL:6HD	SEM	P=
Grower phase						
FSH (IU/mL)	0.307[c]	0.347[c]	0.355[b]	0.571[a]	0.089	0.024
LH (IU/mL)	0.415[c]	0.376[c]	0.720[b]	1.727[a]	0.167	0.001
Oestrogen (pg/mL)	46.2	44.7	44.0	42.1	9.59	0.979
Progesterone (ng/dL)	2.53	3.05	2.78	3.24	0.853	0.850
Prolactin (ng/mL)	8.34[b]	8.36[b]	8.23[b]	14.76[a]	2.24	0.014
Testosterone (ng/dL)	1.68	2.27	1.30	2.23	0.701	0.462
Breeder phase						
FSH (IU/ml)	0.618[b]	0.661[b]	0.663[b]	0.876[a]	0.088	0.028
LH (IU/ml)	0.615[c]	0.576[c]	0.920[b]	1.927[a]	0.167	0.001
Oestrogen (pg/ml)	47.2	45.7	45.0	43.1	9.59	0.979
Progesterone (ng/dL)	2.60	3.08	2.79	3.28	0.846	0.860
Prolactin (ng/mL)	8.99	9.48	9.70	9.98	0.532	0.312
Testosterone (ng/dL)	26.5[d]	29.9[c]	33.6[b]	40.4[a]	0.55	0.001

[abcd] Means with different superscripts in the same row are significantly (P <0.05) different

FSH (0.876 IU/mL), LH (1.927 IU/mL) and testosterone (40.4 ng/dL) levels in the blood were highest (P < 0.05) among birds subjected to 18HL:6HD. Birds on the 12HL:12HD recorded the lowest levels of FSH (0.618 IU/mL), LH (0.615 IU/mL) and testosterone (26.50 ng/dL) (Table 4).

Photoperiod effect on thermo-physiological traits

Thermo-physiological traits were significantly (P < 0.05) affected by photoperiod (Table 5). Birds subjected to 18HL:6HD had the highest (P < 0.05) body temperature (41.57 °C), pulse rate (270.87 Beats/min), respiratory rate (42.69 Breath/min) and rectal temperature (42.95 °C). Birds subjected to 12HL:12HD recorded the lowest (P < 0.05) body temperature (38.14 °C), pulse rate (213.88 Beats/min), respiratory rate (28.18 Breath/min) and rectal temperature (39.55 °C) (Table 5). Table 6 revealed the correlation between thermo-physiological traits as affected by photoperiod. A significant (P < 0.05) positive strong correlations were recorded across all the traits measured.

DISCUSSION

Photoperiod effect on growth performance

One of the most critical microclimatic factors that affect the growth, behavioural pattern and health in Guinea fowl production is the duration of light received by the birds per day. In this study, the findings on growth performance as shown in Table 2 revealed that body weight, weight gain, feed intake and conversion ability increased with increasing light duration. The physiological reasons underlying the increase in growth traits with increasing light duration could be attributed to the light effect on metabolism and higher levels of FSH, LH and testosterone in the blood as reported in this study (Table 4) during the breeder phase. Metabolism is one of the key factors responsible for higher feed utilization, normal growth and proper physiological functioning in birds and similar effects were reported by Abo Ghanima *et al.* (2021).

Light stimulates higher production of thyroid hormones more specifically triiodothyronine which regulates metabolic activities in birds and ensures normal growth and development (Ozkanlar *et al.,* 2021, Riaz *et al.,* 2021). Hence, this explains the reason

Table 5. Thermo-physiological traits as influenced by photoperiod.

Parameters	12HL:12HD	14HL:10HD	16HL:8HD	18HL:6HD	SEM	P =
Body temperature (°C)	38.14[d]	38.69[c]	40.54[b]	41.57[a]	0.112	0.001
Pulse rate (Beats/min)	213.88[d]	222.38[c]	254.50[b]	270.87[a]	0.843	0.001
Respiratory rate (Breath/min)	28.14[c]	28.18[c]	36.038[b]	42.69[a]	0.215	0.001
Rectal temperature (°C)	39.55[c]	40.26[b]	42.69[a]	42.95[a]	0.055	0.001

[abcd] Means with different superscripts in the same row are significantly (P < 0.05) different

Table 6. Correlation between thermo-physiological traits.

Parameters	BT	PR	RR	RT
BT	1			
PR	0.943**	1		
RR	0.927**	0.965**	1	
RT	0.923**	0.960**	0.913**	1

BT= Body temperature, PR= Pulse rate, RR = Respiratory rate
RT= Rectal temperature, ** Correlation is significant at 0.01 level

why Guinea fowls subjected to long duration of light were able to grow faster than Guinea fowls subjected to short light duration.

Again, light stimulates the hypothalamus to trigger the release of growth hormones and sex hormones such as testosterone (Male sex hormones), Oestrogen (Female sex hormones), insulin, cortisol, corticosterone, and progesterone which are responsible for weight management (Ozkanlar *et al.,* 2021). Hence, this explains why in this study body weight and feed consumption increased with increasing levels of photoperiod. These findings were similar to the works done by Abo Ghanima *et al.* (2021), Cui *et al.* (2021), Wu *et al.* (2022) and Okyere *et al.* (2020). Another physiological reason underlying the reduction in body weight and feed intake among birds exposed to short hours of light could also be attributed to the reduction in the time of feeding and access to drinking as reported by Abo Ghanima *et al.* (2021) and Wu *et al.* (2022) as compared with birds on long hours of light exposure.

Photoperiod effect on reproductive traits

Early egg laying and continuous egg production is associated with the duration and intensity of light on a daily basis received by the bird (Cui *et al.,* 2021, Okyere *et al.,* 2020). Findings from this study revealed that Guinea fowls that received 18HL:6HD spent fewer days (130 days) (Table 3) to commence egg laying as compared to Guinea fowls in the other light treatment groups due to the photoperiod effect. This could be explained that in this study, the production of FSH and LH was higher in birds subjected to 18HL as compared with all the other light treatment groups.

Physiologically, light stimulates the pituitary gland which forces the optic nerve to release FSH and LH and the higher the production of these hormones the earlier the birds will lay due to the rapid development of oviduct, follicular growth and development and the release of the ovum (Cui *et al.,* 2021). Hence, the decreasing levels of FSH and LH with decreasing light duration explains the reason why birds on the 12HL:12HD spent 184 days before commencing egg laying. These findings were similar to the works done by Cui *et al.* (2021), Kyere *et al.* (2025), Okyere *et al.* (2020).

Egg weight is regarded as the most important indicator which determines the price of an egg. Hence, it was important to assess the photoperiod effect on egg weight at the start of laying. Findings from this study (Table 3) revealed that egg weight decreased with increasing photoperiod and this could be explained that, at an early (130 days) stage of laying the birds were not mature enough to lay large size eggs (Okyere *et al.,* 2020). Okyere *et al.* (2020) reported that egg weight decreased with increasing photoperiod. The authors further explained that the younger the hens the smaller the size of their eggs and as the hens grow older the birds lay larger-sized eggs. The physiological reason underlying the decrease in egg weight with increasing photoperiod is that, continuous lighting affects the reproductive axis responsible for egg size development. The findings of this study agree with the report of Cui *et al.* (2021) and Okyere *et al.* (2020).

Fertility and hatchability are key indicators to determine the reproductive performance of Guinea fowl hens and cocks. This research revealed that fertility and hatchability of eggs increased with increasing photoperiod with birds subjected to 18HL:6HD having the best fertility while birds on the 12HL:12HD had the poorest percentage fertility. This could be explained that increasing photoperiod stimulates muscle growth, increased cell population and melatonin synthesis leading to higher fertility and hatchability as reported by Archer (2018) and Li *et al.* (2023). Archer (2017) reported that the supply of light during incubation period promotes melatonin synthesis and reduces embryonic death which significantly improves hatchability. The findings of this study are in line with the report of Okyere *et al.* (2020) who reported similar findings.

Photoperiod effect on hormonal levels of the pearl Guinea fowls

Reproductive hormones are responsible for the growth and maturation of birds, egg production and quality and ensure normal physiological functions in poultry birds (Prastiya *et al.,* 2022) but their production depends on photoperiod (Cui *et al.,* 2021, Okyere *et al.,* 2020). The levels of FSH, LH, Prolactin and testosterone observed in this study increased with increasing photoperiod. The increasing trend of these hormones with increasing photoperiod could be explained that, an increase in light duration is associated with higher production of FSH, LH, Prolactin, testosterone and gonadal hormones as reported by Wang *et al.* (2019).

Furthermore, light stimulates the pituitary gland to force the optic nerve to release FSH and LH. Hence, the longer the duration of light the higher the production of these hormones (Cui *et al.,* 2021, Wang *et al.,* 2019). Hence, it is not surprising that birds subjected to long daylight were able to produce a lot of significant reproductive hormones. Higher production of reproductive hormones is important for reproductive success in Guinea fowl production (Okyere *et al.,* 2020). Prastiya *et al.* (2022) reported that FSH and LH are key reproductive hormones that influence reproductive processes such as follicular growth and development and increased ovulation of eggs.

Similar findings were reported by Cui *et al.* (2021) who observed that birds subjected to 18L:6D had the highest levels of FSH, LH and Prolactin as compared with 12L:12D. Cui *et al.* (2021), explains the variation in the levels of hormones observed with increasing photoperiod to the differences in the expression of vasoactive intestinal peptide due to photoperiod effect.

Photoperiod effect on thermo-physiological traits

This study revealed that body temperature, pulse rate, respiratory rate and rectal temperature increased with increasing photoperiod. The body temperature range of 41.57 – 38.14 ºC recorded in this study was within the normal range (41-42 ºC) as reported by Ijadunola *et al.* (2020). Normal body temperature in chickens is important for proper feeding, good health and higher egg production (Maman *et al.,* 2019). When birds are exposed to temperatures above normal (42 ºC) it affects feed intake, growth, and egg production and can lead to death (Ijadunola *et al.* 2020, Maman *et al.,* 2019). Hence, this explains the reason why birds on the 18HL:6HD had the best growth and higher reproductive performance.

The range for pulse rate in this study was observed to be 270.87 - 213.88 Beats/min and was also within the normal range of 200-400 Beats/min reported by Ijadunola *et al.* (2020). Rectal temperature in this study ranges between 42.95 - 39.55 ºC and the maximum rectal temperature of 42.95 ºC was within the normal range of 40.6 - 43 ºC reported by Robertshaw (2004). While the minimum rectal temperature of 39.55 ºC was below the normal range of 40.6 - 43 ºC reported by Robertshaw (2004). However, the range of respiratory rate (42.69 - 28.18 Breath/min) observed in this study was higher than the normal range of 15-30 Breath/min reported by Ijadunola *et al.* (2020). The relationship between all the traits measured was significant and positively strong indicating that each of the traits has a significant effect on the other.

CONCLUSION

This study concludes that increasing photoperiod levels up to 18HL: 6HD promotes rapid growth, reduces age at first egg laying and improves fertility and hatchability of Guinea fowl eggs. Again, FSH, LH, Prolactin and testosterone levels in the blood increased with increasing photoperiod with better productivity.

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Compliance of ethical standard. The authors declare that, they have complied with national and international standards and the research presents original data that has not been sent to another journal. This research was developed from an ongoing PhD research work in Reproductive Physiology (Animal Science). The research followed the Institutional Guidelines for handling poultry birds, teaching and research with approval from the Animal Care and Ethics Committee from the Department of Animal Science, Kwame Nkrumah University of Science and Technology, Kumasi-Ghana. This research also strictly followed the ethics and animal handling guidelines and procedures outline in the Guide (4th Edition 2020, Page 3-7) for the care and use of Agricultural Animals in Research and Teaching by the American Society of Animal Science, and the Poultry Science Association.

Data availability. The raw data that support the findings of this study are available from the corresponding author upon request.

Author contribution statement (CRediT). All authors contributed to the study conceptualization and visualization. **C.G. Kyere** – Data curation, Formal analysis, Investigation, Methodology, Project administration, Software, Writing – original draft, Funding. **S.A. Osei** – Supervision, Validation, Writing – review & editing **M. Boateng** – Supervision, Validation, Writing – review & editing. **Y.O. Frimpong** – Supervision, Validation, Writing – review & editing. **O. Korankye** – Methodology, Resources, Writing – review & editing. **P.A Poku Jnr** – Methodology, Resources, Writing – review & editing. All authors read and approved the final manuscript.

REFERENCES

Abdul-Rahman, I.I., Robinson, J.E., Obese, F.Y., Jeffcoate, I.A. and Awumbila, B., 2016. Effects of season on the reproductive organ and plasma testosterone concentrations in Guinea cocks (*Numida meleagris*). *Poultry Science*, 95 (3), pp. 636-644. https://doi.org/10.3382/ps/pev342

Abo Ghanima, M.M., Abd El-Hack, M.E., Abougabal, M.S., Taha, A.E., Tufarelli, V., Laudadio, V., Naiel, M.A.E., 2021. Growth, carcass traits, immunity and oxidative status of broilers exposed to continuous or intermittent lighting programs. *Animal Bioscience*, 34 (7), pp. 1243–1252. https://doi.org/10.5713/ajas.20.0328

Archer, G.S., 2017. Exposing broiler eggs to green, red and white light during incubation. *Animal*, 11, pp. 1203-1209. https://doi.org/10.1017/S1751731117000143

Archer, G.S., 2018. Effect of two different commercially available white light LED fixtures on broiler hatchability and chick quality. *British Poultry Science*, 59, pp. 251-255 https://doi.org/10.1080/00071668.2018.1436160

Baso, A., Bello, M. U., Sulaiman, H. M., Gosomji, J. I., Omirinde, J. O., Zubairu, M. and Abubakar M. T. (2023) Photoperiod-dependent histomorphological changes in the excurrent duct system of helmeted Guinea fowl subjected to short day (8L:16D), long-day (16L:8D) light/dark cycles and exogenous melatonin. *Veterinary and Animal Science*, 19, pp. 1-10. https://doi.org/10.1016/j.vas.2022.100282

Cao J, Liu W, Wang Z, Xie D, Jia, Chen Y. 2008. Green and blue monochromatic lights promote growth and development of broilers via stimulating testosterone secretion and myofiber growth. *Journal of Applied Poultry Research*, 17, pp. 211–218. https://doi.org/10.3382/japr.2007-00043

Cui, Y.M., Wang, J., Zhang, H.J., Qi, G.H. and Wu, S.G. 2021. Effects of photoperiod on performance, ovarian morphology, reproductive hormone level, and hormone receptor mRNA expression in laying ducks. *Poultry science*, 100 (4), pp. 5-11. https://doi.org/10.1016/j.psj.2021.01.002

Dharani, P.; Ushakumary, S.; Sundaram, V.; Joseph, C. and Ramesh, G. M. 2018. Morphological analysis of testis of the Guinea fowl (*Numida meleagris*) under tropical savannah climate of India. *International Journal of Morphology*, 36 (3), pp. 909-914. http://doi.org/10.4067/S0717-95022018000300909

De-Oliveira, G.R. and Lara, LJ.C., 2016. Lighting programmes and its implications for broiler. chickens. *World's Poultry Science Journal,* 72 (4), pp. 735-742. https://doi.org/10.1017/S0043933916000702

González-Arto, M., Vicente-Carrillo, A., Martínez-Pastor, F., Fernández-Alegre, E., Roca, J., Miró, J., Rigau, T., Rodríguez-Gil, J.E., Pérez-Pé, R., Muiño-Blanco, T., Cebrián-Pérez, A.J. and Casao, A. 2016. Melatonin receptors MT1 and MT2 are expressed in spermatozoa from several seasonal and nonseasonal breeder species. *Theriogenology*, 86 (8), pp. 1958-1968. https://doi.org/10.1016/j.theriogenology.2016.06.016

Gosomji, I.J., Bello, U.M., Dzenda, T., Baso, A., Arukwe, A. and Aire, A.T., 2024. Influence of photoperiod and exogenous melatonin on testis morpho-physiology of sexually mature Guinea fowl (*Numida meleagris*). *Animal Reproduction Science*, 263, pp. 1-13. https://doi.org/10.1016/j.anireprosci.2024.107410

Hajrasouliha, A.R. and Kaplan, H.J., 2012. Light and ocular immunity. *Current Opinion in Allergy and Clinical Immunology*, 12 (5), pp. 504-9. https://doi.org/10.1097/ACI.0b013e328357d3a4

Hao, E.Y., Chen, H., Wang, D.H., Huang, C.X., Tong, Y.G., Chen, Y.F., Zhou, R.Y. and Huang, R.L., 2020. Melatonin regulates the ovarian function and enhances follicle growth in aging laying hens via activating the mammalian target of rapamycin pathway. *Poultry science*, 99 (4), pp. 2185–2195. https://doi.org/10.1016/j.psj.2019.11.040

Ijadunola T.I., Popoola M.A., Bolarinwa M.O., Ayangbola K.A. and Omole, C.A. 2020. Effects of supplemental Vitamins E and C on growth performance and physiological responses of broiler chicken under environmental heat stress. *Nigerian Journal of Animal Science*, 22 (3), pp. 17-25. https://www.ajol.info/index.php/tjas

Keller, A., 1984. Total Serum Protein Determination. Clinical Chemistry, Theory, Analysis and Correlation. St. Lious, Mosby Company, USA. Page: 10-20.

Kuenzel, J.W., Kang, S.W. and Zhou, J.Z., 2015. Exploring avian deep-brain photoreceptors and their role in activating the neuroendocrine regulation of gonadal development. *Poultry Science*, 94 (4), pp. 786-798. https://doi.org/10.3382/ps.2014-04370

Kyere, G.C., Osei, S.A., Boateng, M., Frimpong, Y. O., Jnr. P.A.P and Korankye, O., 2025. Effect of photoperiod on growth and immune responses of the Pearl Guinea fowl in hot humid environment. *International Journal of Veterinary Science*, 14 (1), pp. 101-106. https://doi.org/10.47278/journal.ijvs/2024.216

Li, X., McLean, N., MacIsaac, J., Martynenko, A. and Rathgeber, B., 2023. Effect of photoperiod during incubation on embryonic temperature, hatch traits, and performance of 2 commercial broiler strains. *Poultry Science*, 102 (6), pp. 1-12. https://doi.org/10.1016/j.psj.2023.102632

Maman, H.A., Özlü, S., Uçar, A. and Elibol, O., 2019. Effect of chick body temperature during post-hatch handling on broiler live performance. *Poultry Science*, 98 (1), pp. 244-250. https://doi.org/10.3382/ps/pey395

National Research Council., 1994. Nutrient requirements of poultry. Washington, DC, National Academic Press). ORTIZ, LT, REBOLÉ, A., ALZUETA, C, RODRÍGUEZ, ML & TREVIÑO, J. (2001) Metabolizable energy value and digestibility of fat and fatty acids in linseed determined with growing broiler chickens. *British Poultry Science*, 42, pp. 57-63.

Ozkanlar, S., Kara, H., Gur, C., Gedikli, S., Kara, A., Ozudogru, Z., Ozdemir, D. and Kurt, N., 2021. Effects of photoperiod on thyroid gland development and function in growing chicks: a biochemical and morphometric study. *Animal Production Science*, 61 (16), pp. 1652–1658. https://doi.org/10.1071/AN20687

Okyere, K., Kagya-Agyemang, J.K., Annor, S.Y., Asabere-Ameyaw, A. and Kyere, C.G., 2020. Influence of Season and Day Length on Production and Reproductive Traits and Egg Characteristics of the Guinea Fowl (Numida meleagris). *Asian Journal of Research in Zoology*, 3 (1), pp. 26-34. https://doi.org/10.9734/ajriz/2020/v3i130081

Prastiya, R. A., Madyawati, S. P., Sari, S. Y., and Nugroho, A. P. (2022). Effect of follicle-stimulating hormone and luteinizing hormone levels on egg-laying frequency in hens. *Veterinary world*, 15 (12), pp. 2890–2895. https://doi.org/10.14202/vetworld.2022.2890-2895

Riaz, M.F., Mahmud, A., Hussain, J., Rehman, A.U., Usman, M., Mehmood, S. and Ahmad, S. 2021. Impact of light stimulation during incubation on hatching traits and post-hatch performance of commercial broilers. *Tropical animal health and production*, 53 (107), pp. 1-10. https://doi.org/10.1007/s11250-020-02492-3

Riber, A.B., 2015. Effects of color of light on preferences, performance, and welfare in broilers. *Poultry Science*, 94 (8), pp. 1767-1775. https://doi.org/10.3382/ps/pev174

Robertshaw D., 2004. Temperature Regulation and Thermal Environment, in Dukes' Physiology of Domestic Animals, 12th ed., Reece WO, Ed. Copyright 2004, Cornell University Press.

Wang, Y., Li, Y., Yang, H. and Wang, Z., 2019. Effect of Photoperiod on the Egg Production, Plasma Luteinizing Hormone, Follicle-Stimulating Hormone, Gonadal Hormones, and Mrna Levels of LH and FSH in the Hypothalamic-Pituitary-Gonadal Axis of Pigeons. *Brazilian Journal of Poultry Science*, 21 (4), pp. 1-6. https://doi.org/10.1590/1806-9061-2018-0931

Wu, Y., Huang, J., Quan, S. and Yang, Y., 2022. Light regimen on health and growth of broilers: an update review. *Poultry science,* 101 (1), pp. 1-6. https://doi.org/10.1016/j.psj.2021.101545