ECRONICON OPEN ACCESS

EC VETERINARY SCIENCE
Research Article

Impact of Photoperiod on Productive Performance and Hematological Parameters of the Broilers

Samman Sajjad[2], Naqash Khalid[1]*, Muhammad Fiaz Khan[2], Urooj Sheikh[2], Mohsin Ali[1], Sadia Tabassum[2] and Muhammad Ayaz[1]

[1]*Poultry Research Institute Jaba, Khyber Pakhtunkhwa, Pakistan*

[2]*Department of Zoology, Hazara University, Mansehra, Pakistan*

***Corresponding Author:** Naqash Khalid, Poultry Research Institute Jaba, Khyber Pakhtunkhwa, Pakistan

Received: October 23, 2020; **Published:** November 13, 2020

Abstract

Objectives: The aim of our study was to check the impact of photoperiod on productive performance, mortality percentage and hematological stress parameters of the broilers.

Materials and Methods: In our research study, the three groups of broilers were exposed to different lighting durations i-e 23L:1D (Group A), 16L:8D (Group B) and 8L:16D (Group C).

Results: According to our results, feed and water Intake was significant ($P < 0.05$) till week 2nd and was found non-significant ($P > 0.05$) from 3rd to 5th week among the three groups. Group A (23L: 1D) consumed maximum feed and water. Weight gain was significant ($P < 0.05$) till week 2nd and was found non-significant ($P > 0.05$) from 3rd to 5th week among the three groups. Group B (16L: 8D) gained more weight. Feed Conversion Ratio (FCR) was significant ($P < 0.05$) in the first week while found non-significant ($P > 0.05$) in 2nd, 3rd, 4th and 5th week. Group B (16L: 8D) showed better FCR. Heterophil to lymphocyte ratio (H:L) was observed significant ($P < 0.05$) in first 3 weeks but non-significant ($P > 0.05$) in 4th and 5th week. Group B (16L: 8D) showed closer to the normal H & L ratio. Similarly dressing percentage of group B (16L: 8D) was better than A and C. There was zero mortality recorded throughout experimental period. .

Conclusion: Recorded data concluded that Feed intake of the birds was maximum that were reared in constant light but FCR of the broilers reared under constant light was poor as compared to those reared in reduced photoperiod. Broilers reared under constant light showed increased H/L ratio which indicates more stress in them as compared to reduced photoperiod. Carcass percentage and mortality was unaffected by the photoperiod during their entire life cycle.

Keywords: *Broiler; Feed Conversion Ratio (FCR); Heterophil; Lymphocyte and Carcass Percentage; Photoperiod*

Introduction

In second half of the 20th century the primary purpose of broiler chicken's selection was to get high yield of meat at low cost of production, basically, cost of feed. This result in evolution of hybrids of the broiler chickens whose productive characteristics and target contain achievement of highest biological potential including quick rate of growth, maximum primal carcass cut production and favorable effectiveness of feed conversion, fortify highest cost effectiveness and benefit from this kind of production [1]. Conventionally, to enhance

growth rate, broilers are reared in constant or near constant light and in better housing management [2]. Lighting programs' awareness has recently increased, as governmental, poultry industry and industry customer groups have set guidelines which define lowest light intensities and duration of darkness that should be provided to broiler chickens daily. Constant or nearly constant light duration was once the standard in broiler production and it often used as implicit controlled treatment in photoperiods' studies, since they are commonly considered as enhancing growth rate [3].

Light is essential for sight including both optical sensitivity and allows establishing rhythmicity as well as synchronizing many important functions that includes body temperature, stimulating secretions of several hormones and various metabolic steps that help in feed consumption and digestion [4]. Some betterments have been noticed with short (1L: 2D, 1L: 3D) darkness period through minimum leg problems and improve livability, therefore, growth and FCR remain relatively unaffected or may exhibit slight improvement. Charles, Classen and Robinson [5] showed that increasing the day length stimulates the birds' testes and development of comb. Though, Charles., *et al*. (1992) did not find enhanced plasma and rostenedione concentration under increasing day length a different steroid known as testosterone may get affected [6]. Number of prospective welfare benefits are linked with minimum lighting duration including: enhanced sleep, lower stress response, better immune responsiveness, bone metabolism and leg strength, reduction in mortality and improvement in feed conversion, consequently lower production cost. Melatonin, a neurohormone, is released during dark period by the pineal gland and establishes the internal biological rhythm that govern various daily and seasonal rhythms in various physiological systems including excretory, cardiopulmonary, thermoregulatory, neuroendocrine, behavioral and immune system [4]. When birds are exposed to stressful conditions for a long time, it leads to starvation and they get infected with number of disease causing agents. Facilitating them with adequate light controls many behavioral and physiological functions [7].

As the broiler during different lighting durations was quite during dark period, it was assumed that the reduction of activity during darkness may result in reducing heat production, feed intake and higher feed efficiency.

Purpose of the Study

The purpose of the experiment was to compare the effect of different lighting durations with nearly continuous light duration on productive performance and hematology of broiler.

Materials and Methods

Housing management

The study was carried out under the controlled environment to check the impact of different lighting duration on productive performance and hematology stress indicators of the broilers, at the Poultry Research Institute Jaba. The house was initially cleaned, white washed and properly disinfected. To make the house comfortable, rice husk was used as a litter. Litter was used at 3 - 4 inches deep for each group. Litter turning was practiced to reduce the production of gas in the house. The temperature was maintained at minimum of 70°F and Humidity was maintained around 55 to 60 percent. Floor space of 1 square feet per broiler was provided. Biosecurity measures were taken into account to prevent the mechanical transmission of infection from out to inside of shed.

Experimental birds

Total 90 (cobb-500), one day old broiler chicks (DOC) were purchased from local hatchery for this research study and reared at Poultry Research Institute Jaba to check the impact of photoperiod on feed intake, water consumption, weight gain, FCR, mortality and hema-

tological parameters as stress indicator of broilers. Chicks were weighed on arrival day and were randomly distributed into 3 separate chambers. Three study groups were maintained, with further division of each group into three sub groups (Replicates). Each group contains 30 birds of which each subgroup contains 10 birds.

Lighting schedule

All groups received 23 hours continuous light for first two days. From 3rd day of experiment following treatments of photoperiod were given to these groups.

Group A

Chicks of group A were exposed to continuous light throughout the experiment with the light intensity of 30 lux (according to standard given in Cobb-500 manual) for first two days and 10 lux from day 3rd to the end of the experiment and were considered as control group.

Group B

Chicks of group B were have photoperiod of 16 hours light and 8 hours dark from day 3rd to day 28th and continuous light was given from day 29th to end of the experiment with the light intensity of 10 lux.

Group C

Chicks of group C were have photoperiod of 8 hours light and 16 hours dark from day 3rd to day 28th and continuous light was given from day 29th to end of the experiment with the light intensity of 10 lux.

Diet

The same feed and water was given to all the three experimental groups till the end of experiment. The given feed was *ad-libitum* and were had free access to feed and water. For the first two weeks of the study, mash feed was offered to the birds. The feed was provided twice a day and the left over feed from the feeders was weighed. In order to calculate the feed consumption of the chicks, the remaining feed was subtracted from the total feed given. Throughout the study, the fresh water was supplied to the broilers.

General management

The general management of the broilers including vaccination was followed according to the broiler's general guidelines. One-day old chicks were vaccinated with ND+IB through ocular route on arrival day. On day 7, ND lasota vaccine was used against Newcastle disease as booster dose and an 14th day vaccination against Gumboro disease (Infectious Bursal Disease) was done. One of the challenges for rearing of the birds was the maintenance of optimal temperature in incubation chambers especially during brooding period. In the first week 95°F temperature was provided. Temperature of 90°F was provided in 2nd week according to the standard protocol. After the optimal temperature conditions, the chicks were properly spread over the floor and actively consumed feed.

Data collection

On arrival day, chicks were weighed and weight gain was recorded and then distributed them randomly into three separate rooms. Furthermore, birds were weighed on day 7th, 14th, 21st, 28th and 35th by means of weight balance and mean weight of the birds in each group was recorded. The feed intake by birds of each group in the experiment was recorded on day 7, 14, 21, 28 and 35. The feed was given

twice a day to the chicks, was calculated and left over feed in the feeder was also weighed at the end of the day. The weighing of feed given at morning of every day and feed consumed in a day was obtained as the difference between the amount given and the amount left in the feeder on the following day to obtained daily feed intake by the chicks of the group, and the feed consumed per chick was obtained as the total feed consumed in a group divided by number of chicks in each group [8]. Feed conversion ratio (FCR) was also recorded at day 7, 14, 21, 28 and 35. The FCR were calculated as the total feed consumed by a chick divided by weight gain by a chick. Feed conversion ratio = intake of feed ÷ weight gain [8]. Random selection of 6 chicks per group was selected for collection of blood through wing vein on day 7, 14, 21, 28 and 35. Blood samples were collected in clean plastic vacutainer (BD, Germany) tubes with EDTA anticoagulant. Blood smears were prepared with EDTA anticoagulant blood for the purpose of minimizing degenerative changes in the blood. Differential leukocyte count (DLC) was performed at poultry research institute Jaba. For DLC, a clean microscope glass slide was used and one drop of fresh blood of about 2 mm (diameter) smeared on it. Another slide was used as spreader was placed at 40° to the slide and made a film of 3 - 4 cm in length. The smear was left for drying. Film of blood was used with methyl alcohol for 2 minutes and pour the Giemsa stain diluted 1:9 with buffer over the smear for 3 - 4 minutes. Wash off using buffer, dried it and was examined without coverslip. Heterophil and lymphocytes were counted in 100 cells per field under the light microscope. Their ratio was calculated by dividing number of heterophil with lymphocyte number and recorded [9]. On completion of the experimental period, all broilers from three groups were slaughtered to complete bleeding and weighed to determine dressing percentage using formula (Dressed carcass weight ÷ Live weight x100) and dressing percentage was recorded separately for each group [10].

Statistical analysis

Collected data was analyzed statistically through ANOVA. Analysis of variance was done by using complete randomized design (CRD) and was computed to check the significance and insignificance among the treatment groups by using JMP software [11].

Results

Feed intake

Feed intake of all the three groups of the experiment was recorded on weekly basis and the results showed that feed intake was significant ($P < 0.05$) till 2nd week of the experiment. From 3rd week to the 5th week of the study, the feed intake among the groups was non-significant ($P > 0.05$) as shown in table 1.

Week	Group A	Group B	Group C	P value
1st	134 ± 3.74	127 ± 3.74	107 ± 2.94	< 0.05
2nd	353 ± 3.74	342 ± 5.35	304 ± 5.71	< 0.05
3rd	625 ± 7.48	618 ± 4.5	520 ± 6.68	> 0.05
4th	831 ± 1.63	820 ± 5.71	648 ± 3.26	> 0.05
5th	1137 ± 7.12	1121 ± 6.48	1127 ± 3.26	> 0.05

Table 1: *Effect of photoperiod on food intake (g/bird) of broilers during the trial period in various groups.*

Water intake

Water intake of all the three groups of the experiment was also recorded on weekly basis and the results shows that water intake was significant ($P < 0.05$) till week 2nd of the experiment. From week 3rd to week 5th, the feed intake was non-significant ($P > 0.05$) among the three groups of experiment as shown in table 2.

Week	Group A	Group B	Group C	P value
1st	268 ± 4.90	257 ± 860	216 ± 8.60	< 0.05
2nd	699 ± 10.80	674 ± 10.71	598 ± 11.43	< 0.05
3rd	1240 ± 14.97	1226 ± 9.09	1030 ± 13.37	> 0.05
4th	1652 ± 3.26	1630 ± 11.43	1286 ± 6.53	> 0.05
5th	2228 ± 17.28	2236 ± 17.20	2248 ± 10.70	> 0.05

Table 2: *Effect of photoperiod on water intake (ml/bird) of birds during the trial period in various groups.*

Total body weight (g/bird)

Total body weight of all the three groups was recorded on weekly basis and presented in the table. Results shows that there is a significant difference (P < 0.05) in total body weight from day 0 to 3rd week and a non-significant difference (P > 0.05) was observed in week 4th and 5th as shown in table 3.

Week	Group A	Group B	Group C	P value
0	45 ± 0.817	44 ± 0.817	45 ± 0.817	< 0.05
1st	190 ± 2.94	197.3 ± 8.99	176 ± 6.68	< 0.05
2nd	504 ± 5.89	512 ± 3.56	446 ± 4.55	< 0.05
3rd	938 ± 2.94	952 ± 5.35	894 ± 8.83	< 0.05
4th	1552 ± 12.19	1572 ± 10.61	1322 ± 10.03	> 0.05
5th	2248 ± 8.28	2279 ± 6.68	2018 ± 4.55	> 0.05

Table 3: *Effect of photoperiod on total body weight (g/bird) of birds during the trial period in various groups.*

Weight gain (g/bird)

Weight gain of all the three groups was recorded on weekly basis and presented in the table. Results indicates that there is a significant difference (P < 0.05) in weight gain from week 1st to 3rd and a non-significant difference (P > 0.05) was recorded on week 4th and 5th which is shown in table 4.

Week	Group A	Group B	Group C	P value
1st	145 ± 2.83	153 ± 9.39	131 ± 7.48	< 0.05
2nd	314 ± 6.68	314.6 ± 11.95	296.6 ± 13.09	< 0.05
3rd	434 ± 3.74	440 ± 8.29	428 ± 9.42	< 0.05
4th	614 ± 10.70	620 ± 8.48	428 ± 8.52	> 0.05
5th	696 ± 4.32	707 ± 17.20	696 ± 11.04	> 0.05

Table 4: *Effect of photoperiod on weight gain (g/bird) of birds during the trial period in various groups.*

Feed conversion ratio

Feed Conversion Ratio of all the three groups was recorded on weekly basis and presented in the following table. FCR of group B (1.586 ± 0.04) is better than group A (1.603 ± 0.004) and group C (1.62 ± 0.032). Results shows that there is a significant ($P < 0.05$) difference in feed conversion ratio in the first week of experiment while there is a non-significant ($P > 0.05$) difference in FCR in 2nd, 3rd, 4th and 5th week of experiment as shown in table 5.

Week	Group A	Group B	Group C	P value
1st	0.917 ± 0.033	0.833 ± 0.067	0.82 ± 0.050	< 0.05
2nd	1.123 ± 0.036	1.086 ± 0.033	1.032 ± 0.038	> 0.05
3rd	1.44 ± 0.029	1.40 ± 0.036	1.19 ± 0.050	> 0.05
4th	1.353 ± 0.028	1.32 ± 0.016	1.51 ± 0.038	> 0.05
5th	1.603 ± 0.004	1.586 ± 0.041	1.62 ± 0.032	> 0.05

Table 5: *Effect of Photoperiod on FCR of birds during the trial period in various groups.*

Differential leukocyte count (DLC)

Heterophil

Heterophil count of all the three groups of the experiment was recorded on weekly basis and then presented in the table. Results showed that there is a significant difference ($P < 0.05$) in the heterophil count from 1st to 3rd week of the experiment while found a non-significant difference ($P > 0.05$) in 4th and 5th week of the experiment as shown in the table 6.

Week	Group A	Group B	Group C	P value
1st	24.3 ± 0.471	24.3 ± 0.47	24.6 ± 0.471	< 0.05
2nd	25.67 ± 0.471	25.33 ± 25.33	25.33 ± 0.471	< 0.05
3rd	27.33 ± 0.471	27.33 ± 0.471	27.66 ± 0.471	< 0.05
4th	29.33 ± 0.471	30 ± 0.816	30.33 ± 3	> 0.05
5th	31.33 ± 0.471	32.33 ± 0.471	32.33 ± 0.471	> 0.05

Table 6: *Effect of photoperiod on heterophils (%) of broilers during the trial period in various groups.*

Lymphocytes

Lymphocytes count of the three groups A, B and C of the experiment was recorded on weekly basis and presented in the table. Results showed that there is a significant difference ($P < 0.05$) in lymphocytes count from week 1st to 3rd while a non-significant difference ($P > 0.05$) lies in week 4th and 5th of experiment as shown in table 7.

Week	Group A	Group B	Group C	P value
1st	63 ± 0.816	63 ± 0.816	63 ± 0.816	< 0.05
2nd	61 ± 0.816	61 ± 0.816	60 ± 0.471	< 0.05
3rd	58.67 ± 0.471	58.67 ± 0.471	58.67 ± 0.471	< 0.05
4th	55.67 ± 0.471	55 ± 0.816	55 ± 0.816	> 0.05
5th	53 ± 0.816	52.67 ± 0.471	52.33 ± 0.471	> 0.05

Table 7: *Effect of photoperiod on lymphocyte (%) of broilers during the trial period in various groups.*

Heterophil-lymphocyte ratio

Heterophil-lymphocyte ratio of the three groups of experiment was recorded on weekly basis and presented in the table. Results showed that there is a significant difference ($P < 0.05$) till 3rd week of the experiment while in 4th and 5th weeks of the experiment there were non-significant difference ($P > 0.05$) in H/L ratio among the three groups of the experiment as shown in the table 8.

Week	Group A	Group B	Group C	P value
1st	0.39 ± 0.004	0.39 ± 0.012	0.39 ± 0.008	< 0.05
2nd	0.42 ± 0.014	0.42 ± 0.004	0.42 ± 0.008	< 0.05
3rd	0.47 ± 0.009	0.46 ± 0.004	0.47 ± 0.008	< 0.05
4th	0.52 ± 0.009	0.54 ± 0.016	0.55 ± 0.021	> 0.05
5th	0.59 ± 0.008	0.61 ± 0.008	0.62 ± 0.014	> 0.05

Table 8: *Effect of photoperiod on heterophils/lymphocytes (%) of broilers during the trial period in various groups.*

Dressing percentage

Dressing percentage of all the three groups of the experiment was recorded on 35th day and presented in table. Results showed that the dressing percentage of group C is better than group A and B as shown in table 9.

Group A (%)	Group B (%)	Group C (%)
67 ± 0.0003	66.97 ± 0.0005	67.01 ± 0.0009

Table 9: *Effect of photoperiod on dressing (%) of broilers during the trial period in various groups.*

Total mortality

There was no mortality recorded throughout our experiment. Hence the mortality percentage of all the three groups A, B and C is 0%. So, the photoperiod had no effect on the mortality of the broilers.

Discussion

Recorded results showed that the birds exposed to 23L: 1D consumed more feed (1137 ± 7.12) than other two groups (1121 ± 6.48 and 1127 ± 3.26). Our results are similar with the study of Coban, Lacin and Genc [12] they suggested that according to lighting programs,

broiler chickens modify their feeding behavior. Similarly Schwean-Lardner, Fancher and Classen [13] reported that extending the day length increased feed intake during the period up to day 21, while between 22 - 35 days photoperiods longer than 6 hours resulted in similar feed intake ratios [12]. In another study, it was observed that after the dark phase broiler rushed towards feeder because the upper digestive tract of the birds might have been empty during dark period, and they immediately ready to take feed when light get on. The study of Schwean-Lardner., *et al*. [13] reveals that longer period of darkness prevents the birds to access food results in reduction in feed intake and has limited growth.

According to the present study, the birds exposed to 16L: 8D photoperiod gain more weight (2279 ± 6.68) as compared to other two groups A and C (2248 ± 8.28 and 2018 ± 4.55) maybe because the dark period let the birds to digest the food completely so they gain more body weight. The present study correlated with the study of Farghly and Makled [4] according to them lighting program showed a significant effect on weight gain at 1 - 3 and 1 - 6 weeks of age, which indicates that broilers exposed to intermittent light exhibited higher body weight gain than the birds reared under continuous light. Birds exposed to continuous light are more active than related with more stress response, which disturbs their food metabolism that leads to low growth performance. Since physical activity which saves energy expenditure, reduction in physical activity during darkness may also contribute to increased production efficiency [14]. In another research, where male broiler chicks were incubated in three different light patterns, Rozenboim, Robinzon and Rosenstrauch [15] suggested that the groups of chicks reared in 16L: 8D and 23L: 1D did not showed any significant difference for body weights of broilers.

In our study the birds reared under 16L: 8D have better feed conversion ratio (FCR 1.586 ± 0.041) expected the reason that they have enough dark period during which they digest their feed and gain more weight. In contrast to our findings, broilers housed in nearly constant light schedule showed better FCR and maximum body weight gain [16]. This may be due to change in managemental or environmental conditions. Our study correlated with the study of Ingram, Hattens III and McPherson [17], they reported improved feed conversion ratio in experimental group 12L: 12D versus control group 23L: 1D, in birds. Similarly, feed conversion rate was increased in broiler incubated under 12L: 12D light program in comparison with 23L: 1D [18]. Downs, Lien, Hess, Bilgili and Dozier III [19] studied insignificant impact of photoperiod on FCR. Feed conversion rate was significantly reduced in broiler chickens incubated under 16L: 8D lighting period in comparison to 23L: 1D and 20L: 4D [20]. Feed conversion ratio (FCR) of the chicks reared intermittent light was better than the continuous light broiler chickens [14]. In the study of Onbasilar., *et al*. [2] FCR of broiler chickens exposed to 16L: 8D lighting duration was 1.59 and that of birds exposed to 24L: 0D lighting pattern was 1.57, this difference was statistically non-significant.

In the present study, the broilers reared under the photoperiod of 23L: 1D were had increased heterophil to lymphocytes ratio, expressing the stress condition in the broilers as compared to the broilers reared under 16L: 8D and 8L: 16D lighting programs. Continuous light (23L: 1D) suppresses the level of melatonin hormone due to which chicks suffers lack of sleep, which causes oxidative stress among the chicks resulting in increase in H/L ratio. This study correlates to the study of Coban., *et al*. [12] who studied that the H/L rate of the self-photoperiod and 16L: 8D groups were decreased than those of the 24L: 0D. Similarly, Coban., *et al*. [12] reported minimum H/L ratio in self-photoperiod groups than birds reared under continuous lighting. The study of Campo, Gil, Dávila and Muñoz [21] is similar with our results and stated that constant light induced stress in broilers, therefore, results in increase the H/L ratio. However, Lien., *et al*. [3] recorded that the H/L rate of the groups reared in short and long photoperiods were almost equal. According to Farghly and Makled [4] replacing dark hours with lighting may help early growth by providing the broilers more opportunity to see the feed, lower heat production and stimulates the secretion of several hormones.

Carcass weight of the birds was unaffected by photoperiod length in our study. This study is correlated to the results of Coban., *et al*. [12] and Downs., *et al*. [19] who reported that there was non-significant difference between broilers' carcass yields reared under differ-

ent light programs. Weight of internal organs of birds in all the groups was similar. In male quails, Coban., *et al*. [12] also suggested that percentage of internal organs were unaffected by day length. The present study is contrast with the study of Coban., *et al*. [12] according to them, in photoperiod of 16L: 8D group, the carcass rate was higher than other groups this may be due to difference in environmental conditions. In contrast to our study, Renden, Bilgili and Kincaid [22] has compared the impact of 16L: 8D and 23L: 1D; and reported that in 23 hours lighting program, breast meat of the carcasses increased; while birds reared in short photoperiod length, the whole legs' rate of the carcasses were maximum than the ones, incubated in longer photoperiod. In the study of Lewis., *et al*. constant lighting enhanced the percentage of breast meat [12]. Lien., *et al*. [3] also reported that extending the day length from 16 hours to 23 hours increased the percentage of breast. In contrast to the previous results, present study reveals that legs and breast percentages were not get affected by photoperiod. Carcass characteristics and internal organs percentage were unaffected significantly by lighting pattern [2].

In our present study, there was zero mortality recorded throughout the experimental period, hence it proves that the photoperiod length has no effect on mortality of the birds. These results are similar to the results of Lien., *et al*. [3] which indicate that there is non-significant impact of photoperiod on mortality of birds. Our present study contradicts with the study of Olanrewaju., *et al*. [23], according to which continuous lighting induces stress in broilers and results in high mortality rate.

Conclusion

Recorded data concluded that feed intake of the birds was maximum that were reared in constant light, but FCR of the broilers reared under constant light was poor as compared to those reared in reduced photoperiod. Broilers reared under constant light showed increased H/L ratio which indicates more stress in them as compared to reduced photoperiod. Carcass percentage and mortality was unaffected by the photoperiod during their entire life cycle.

Conflict of Interest

The authors don't declare any conflict of interest.

Bibliography

1. Bogosavljević-Bošković S., *et al.* "Broiler rearing systems: a review of major fattening results and meat quality traits". *World's Poultry Science Journal* 68.2 (2012): 217-228.

2. Onbasilar E., *et al.* "Influence of lighting periods and stocking densities on performance, carcass characteristics and some stress parameters in broilers (2008).

3. Lien R., *et al.* "Effect of light intensity and photoperiod on live performance, heterophil-to-lymphocyte ratio, and processing yields of broilers". *Poultry Science* 86.7 (2007): 1287-1293.

4. Farghly M and Makled M. "Application of intermittent feeding and flash lighting regimens in broiler chickens management". *Egyptian Journal of Nutrition and Feeds* 18.2 (2015): 261-276.

5. Charles R., *et al.* "Effect of long constant and increasing photoperiod lighting programs on plasma androstenedione and growth of male broiler chickens". *Poultry Science* 68 (1989): 26.

6. Charles R., *et al.* "Growth, body composition, and plasma androgen concentration of male broiler chickens subjected to different regimens of photoperiod and light intensity". *Poultry Science* 71.10 (1992): 1595-1605.

7. Mustafa YS and Muneer MA. "Influence of light on the hematology, lymphoid organs and production of the broilers". *Sarhad Journal of Agriculture* 29.4 (2013): 579-584.

8. Aji SB., *et al.* "Effect of feeding onion (Allium cepa) and garlic (Allium sativum) on some performance characteristics of broiler chickens". *Research Journal of Poultry Sciences* 4 (2011): 22-27.

9. Haskins DL. "Physiological and immunological effects of coal combustion residues in the yellow-bellied slider". *University of Georgia* (2016).

10. Shewita R and Taha A. "Effect of dietary supplementation of different levels of black seed (Nigella Sativa L.) on growth performance, immunological, hematological and carcass parameters of broiler chicks". *World Academy of Science, Engineering and Technology* 77 (2011): 788-794.

11. Gullu S., *et al.* "Effects of levothyroxine treatment on biochemical and hemostasis parameters in patients with hypothyroidism". *European Journal of Endocrinology* 152.3 (2005): 355-361.

12. Coban O., *et al.* "The effect of photoperiod length on performance parameters, carcass characteristics and heterophil/lymphocyte-ratio in broilers". *Kafkas Universitesi Veteriner Fakultesi Dergisi* 20.6 (2014): 863-870.

13. Schwean-Lardner K., *et al.* "Impact of daylength on the productivity of two commercial broiler strains". *British Poultry Science* 53.1 (2012): 7-18.

14. Rahimi G., *et al.* "The effect of intermittent lighting schedule on broiler performance". *International Journal of Poultry Science* 4.6 (2005): 396-398.

15. Rozenboim I., *et al.* "Effect of light source and regimen on growing broilers". *British Poultry Science* 40.4 (1999): 452-457.

16. Abreu VMN., *et al.* "Curtain color and lighting program in broiler production: I-general performance". *Revista Brasileira de Zootecnia* 40.9 (2011): 2026-2034.

17. Ingram D., *et al.* "Effects of light restriction on broiler performance and specific body structure measurements". *Journal of Applied Poultry Research* 9.4 (2000): 501-504.

18. Mahmood S., *et al.* "An Augmented Review about Lighting programs for Broiler Production" (2014): 1-3.

19. Downs K., *et al.* "The effects of photoperiod length, light intensity, and feed energy on growth responses and meat yield of broilers". *Journal of Applied Poultry Research* 15.3 (2006): 406-416.

20. Scott T. "Evaluation of lighting programs, diet density, and short term use of mash as compared to crumbled starter to reduce incidence of sudden death syndrome in broiler chicks to 35 d of age". *Canadian Journal of Animal Science* 82.3 (2002): 375-383.

21. Campo J., *et al.* "Effect of lighting stress on fluctuating asymmetry, heterophil-to-lymphocyte ratio, and tonic immobility duration in eleven breeds of chickens". *Poultry Science* 86.1 (2007): 37-45.

22. Renden J., *et al.* "Live performance and carcass yield of broiler strain crosses provided either sixteen or twenty-three hours of light per day". *Poultry Science* 71.9 (1992): 1427-1435.

23. Olanrewaju H., *et al.* "A review of lighting programs for broiler production". *International Journal of Poultry Science* 5.4 (2006): 301-308.

Volume 5 Issue 12 December 2020