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(Original Article)

Effect of Lighting Programs on Compensatory Growth of Broiler Chickens

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Abstract

The aim of the experiment was to study the influence of lighting programmes on compensatory growth and carcass criteria of broiler chickens. A total number of 120 (one hundred twenty) Ross broiler chicks, one day old were equally divided into 3 treatments of 40 chicks each and further divided into 4 replicates (10 chicks/ replicate). The experimental lighting regime treatments were as follows: continuous, light stimulation and intermittent lighting. The results showed that the birds exposed to T1, and C achieved the highest BW and BWG compared to birds exposed to intermittent lighting. During the period from (0-6) wks of age, birds in groups (C) and (T1) achieved an increase in BWG and improved FCR than the group in (T2). In conclusion results suggested the application of a light stimulation better performance minimizing electricity costs.

Keywords: *Broiler chicks, Lighting programme, Performance, Carcass, Growth.*

Introduction

The influence of light on poultry production includes colour, intensity and duration of light. It has vital role in poultry industry (Wu *et al*., 2022). Light is also essential for all functions of poultry growth and reproduction. At the same time, darkness plays the same previous functions for poultry (Patel *et al*., 2016).

Continuous lighting program is not recommended as an ideal program because it reduces both activity and sleeping time leading to reducing the heat production by about 25% and increasing the melatonin levels in poultry (Farghly *et al*., 2016). This programme is accompanied by improving both the consumption of feed and weight gain but appears some problems concerning leg abnormalities and are more immunologically fragile (Liboni *et al*., 2013).

Stimulation light effect on behaviour, health, and performance of poultry. however, some studies determined the pattern of stimulation light required to produce these effects (Archer and Mench, 2014).

The effect of the photoperiod on poultry production is useful to reduce the adverse effect of heat stress on feed intake. Light is a tool used to regulate both feed intake and water for the poultry industry (De Oliveira and Lara, 2016).

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Intermittent lighting programs reduce production costs, and the chickens are more active and good performance during the light periods (Rahimi *et al*., 2005 and Manfio *et al*., 2019). The increase in lighting programme during intermittent light gives increased schemes in photoperiod according to the increases in the age (Liboni *et al*., 2013).

Materials and Methods

The present work was carried out at the Poultry Research Farm, Poultry production Dept. Faculty of Agriculture, Assiut University, Egypt.

Birds and managements

A total number of 120 (one hundred twenty) Ross broiler chicks, one day old were used. Chicks were wing-banded and naturalized by wing feathers. All chicks were weighted to the nearest gram and equally divided into 3 treatments, four replicates of 10 chicks each, five males and five females. All chicks were placed in each pen (2 × 0.75 × 1) m. Experimental pens were equipped with a pan feeder, a manual drinker, ventilation and a gas heating system to provide the required temperature. Chicks were placed in floor pens covered with straw litter material (5 cm depth). White LED bulbs light were used. The pens were separated by blackout curtains and equipped with ventilation, and a gas heating system to provide the required temperature.

Chicks were fed commercial diets in pellet form purchased from feed mix Egypt Poultry Company. The temperature was kept at 34ºC from the first three days then gradually decreased to 2ºC every three days till 24ºC. Humidity was kept at 50 – 70%. Chicks were vaccinated against several diseases. Feed was provided ad libitum and water was also provided by same way. Chicks were received the diets during all stages of age according to NRC (1994) (Table 1).

Table 1. The composition and proximate chemical analysis of the basal starter, grower and finisher diets

Ingredients	Starter diet (%)	Grower diet (%)	Finisher diet (%)
Yellow corn grains	50.55	57.23	62.59
Corn Gluten (60% CP)	5.20	4.90	4.60
Soybean meal (44% CP)	36.00	29.79	24.70
Limestone ($CaCO_3$)	1.35	1.10	1.08
Di-phosphate calcium	1.90	1.67	1.55
Salt (NaCL)	0.40	0.40	0.40
Soya oil	3.50	4.00	4.25
Vitamins minerals mixture*	0.30	0.30	0.30
DL Methionine	0.31	0.25	0.21
Lysine-HCL	0.32	0.25	0.23
Total	100	100	100
Calculated analysis			
Metabolizable energy kcal/kg diet	3046	3157	3238
Crude protein, %	23.01	21.03	19.04
Crude fiber, %	3.86	3.45	3.30
Crude fat, %	5.50	5.80	5.80
Calcium, %	1.07	0.90	0.85
Available phosphorus, %	0.51	0.45	0.42
Methionine & Cysteine %	0.69	0.60	0.55
Lysine %	1.45	1.25	1.10
Moisture, %	12.00	12.00	12.00

*Each 3 Kg of premix contains: Vitamins: A: 12000000 IU; Vitamins; D3 2000000 IU; E: 10000 mg; K3: 2000 mg; B1:1000 mg; B2: 5000 mg; B6:1500 mg; B12: 10 mg; Biotin: 50 mg; Choline chloride: 250000 mg; Pantothenic acid: 10000 mg; Nicotinic acid: 30000 mg; Folic acid: 1000 mg; Minerals: Mn: 60000 mg; Zn: 50000 mg; Fe: 30000 mg; Cu: 10000 mg; I: 1000 mg; Se: 100 mg and Co: 100 mg.

Experimental design

The three experimental groups were as follow:

Control (C) 24 hours of continuous lighting during all periods of the experiment.

Treatment 1 (T1) Light Stimulation

Age (days)	Number of daily lighting hours
1- 3d	24 hours continuous lighting
3 – 15d	12 h Light + 12h Dark
15 – 22d	16 h Light + 8h dark
23 – 42d	24 hours continuous lighting

Treatment 2 (T2). Intermittent lighting.

Age (days)	Number of daily lighting hours
1 – 21d	24 hours continuous lighting
22 – 35d	3 h light + 1 h dark
36 – 42d	2 h light + 1 h dark

Experimental measurements

Birds of each replicate was individually weekly weighted to the nearest gram during the period from 0 to 6 weeks of age and body weight gain (BWG) was calculated during the period from 0-3, 3-6 and 0-6 weeks of age. Feed consumption (FC) and feed conversion ratio (FCR) for each replicate was recorded during the same previous periods.

Carcass criteria

At 6 wks of age, 4 birds/ treatment within the average body weight of the group were taken, birds were weighed and slaughtered by cutting the neck near the first cervical vertebra, and left to bleed freely for 10 minutes, then carcass parts, giblets (liver, heart, gizzard) and (spleen, bladder) weights were recorded. Internal organs and carcass cut-up parts were expressed relatively to the live body weight of the birds. Dressed carcass percentages were calculated as follows:

$$\textbf{Dressed carcass \%} = \frac{\textbf{Carcass and giblets weight (g)}}{\textbf{Live body weight (g)}} \times \mathbf{100}$$

Plumage condition and leg problems

The scoring of Plumage conditions was graded from 1 to 5, however, 1 means no breast blisters and 5 means large. In regard to leg problems (foot pad burns, hock discolouration), the scores ranged from 1 (no leg problems) to 5 (high leg problems).

Statistical analysis

The obtained data were analyzed by analysis of variance, ANOVA using the General Linear Models (GLM) procedure of SAS software SAS procedure (Version 9.2, 2009). Duncan's multiple range test (Duncan, 1955) was used to determine differences among means when treatment effects were significant a level ($P<0.05$). The mathematical model used was: $Yik = \mu + Ti + eik$, Where: Yik = The individual observation, μ=The overall mean, Ti = Treatment effect, (i = 1,2,3,4 and 5) and eik = The experiment error.

Results and Discussion

Growth Performance

The results of body weight (BW), body weight gain (BWG), feed consumption (FC) and feed conversion ratio (FCR) of broiler chickens as affected by lighting regimes are presented in Table (2).

Body Weight (BW) and Body Weight Gain (BWG):

Data showed that during the 3rd and 6th weeks of age, the birds exposed to light stimulation (T1) and the control group (C) achieved the highest BW ($P\leq0.05$) compared to birds exposed to intermittent light. Control group did not differ significantly in BW when compared with T2. The obtained results are in the same trend with that reported by Soliman and Hassan (2019), Ghanima *et al*., (2021) and Sodella and Gous (2022).

Also, the results in Table (2) showed that chicks exposed to an intermittent lighting programme (T2) had the lowest BW compared to the other treatments. The obtained results are in disagreement with, Coban *et al*. (2014) Kalaba *et al*., (2016) and Nelson *et al*., (2020) in broilers.

Data showed that during the periods from (0-3) and (0-6) wks of age, the birds in the control group (C) and light stimulation (T1) achieved the highest BWG compared to (T2) intermittent lighting. The obtained results agree with that mentioned by Fidan *et al*., (2017), Soliman and Hassan (2019) and Ghanima *et al*., (2021).

The obtained results are also showed that birds on intermittent lighting programme have the lowest BWG compared to the other treatments. Similar trends were achieved by several authors such as Mahmud *et al*., (2011), Yang *et al*., (2015) and Manfio *et al*., (2019).

Slowing early growth as a result of the lighting programme allows chickens to get mature physiologically prior to before the maximum rate of growth muscle (Olanrewaju *et al*., 2019). Lighting programs is applied depending on feed restriction in the early stages, then after a period of gradual extension of the light period coming to a compensatory growth induced by abundant hormone activity (Škrbić *et al*., 2012).

The initial growth of chickens as a result of the gradual levels of photoperiod and the occurrence of compensatory growth, allows some of metabolic disorders and skeletal problems will appears (Škrbić *et al*., 2012).

Feed Consumption (FC) and Feed Conversion Ratio (g feed/g gain):

Data showed that there were no significant effects due to lighting programmes on FC during all the periods studied.

Several reports indicated that the lighting programme had no effect on feed consumption such Soliman and Hassan (2019) who found that no significant effects on the overall feed intake between all groups under different light systems. Fidan *et al*., (2017) and Coban *et al*. (2014) found that no significant effects feed consumption between the two groups of chickens kept on increasing duration of photoperiod at 24 h/ d and those on 23L: 1D. No difference in feed intake between chicks raised on continuous light (CL) and intermittent light (IL) ,1 h L: 3 h D chickens in all phases of the experiment (Rahimi *et al*., 2005). In some experiments feed intake of IL chickens were higher than the CL groups in 3-6 weeks of age

The obtained results disagree with Manfio *et al*., (2019), Zhao *et al*., (2019) and Sodella and Gous (2022).

Increasing dark period reducing the energy requirements of chickens as a result of reducing their metabolic rate (Classen, 2004). It was believed that chickens kept on more frequent alternation of light and dark periods would be more active during periods of light (Ferrante *et al*., 2006) and that the rhythm of feeding in moderate photoperiod changed so that the peak of the food consumption was reached at the beginning and at the end of the light period (Gordon, 1999).

During the period from 0-3 wks of age, the results showed no significant ($P>0.05$) effects on feed conversion ratio due to lighting programs. During (3-6)

and (0-6) weeks of age, the broiler chicks of control and T1 had significantly better (P≤0.05) FCR than those of in T2, while control did not differ significantly in feed conversion ratio when compared with T1 group.

These results are in agreement with Zheng *et al*., (2013) who mentioned that no differences in feed conversion ratio (FCR) of broilers under light regimens of both constant (24L: 0D) and intermittent lighting programmes (17L: 3D:1L: 3D) and (16L: 2D:1L: 2D:1L: 2D). El-Sagheer *et al*., (2004) concluded that there were no significant differences from 1 to 7 weeks of age in FCR among all different lighting programmes. Also, the results showed that birds kept on intermittent lighting programme achieved the worst FCR compared to the other treatments. The obtained results are in disagreement with the reported by Yildiz *et al*. (2009), El-Slamoney *et al*., (2010), Mustafa and Muneer, (2013) and Yang *et al*., (2015).

In this respect, El-Sabry *et al*., (2015) reported that chicks that were subjected to split darkness exhibited longer gastrointestinal tract and jejunum length and wider villi as opposed to those of birds exposed to constant photoperiod. Feed

Efficiency is improved with decreasing day length (longer night periods); the best feed efficiency occurred when broilers were given 14 hours of light regardless of market age (Schwean and Classes, 2010). This improvement in feed efficiency is not due to differences in body weight gain but may be due to reduced maintenance requirements as a result of the lower metabolism that occurs during darkness (Pal *et al*., 2017).

Mortality Rate (MR)

No mortalities occurred among the different groups of all ages. Therefore, it seems that lighting programmes had no effect on MR.

Table 2. Effect of lighting programmes on body weight, body weight gain, feed

Variable	Treatments		
	(C)	(T1)	(T2)
Body Weight (g)			
One day old	44.18±0.45	43.26±0.42	43.40±0.34
3rd WK	918.50±12.87^{a}	929.13±14.76^{a}	882.25±9.37^{b}
6th WK	3133.38±46.83^{a}	3085.88±47.13^{a}	2775.75±49.16^{b}
Body Weight Gain (g/bird)			
0 - 3 WK	874.42±12.42^{ab}	885.8±12.80^{a}	838.85±13.97^{b}
3 - 6 WK	2214.88±42.12^{a}	2156.75±30.46^{a}	1893.50±63.65^{b}
0 - 6 WK	3089.30± 39.51^{a}	3042.61± 42.42^{a}	2732.35± 75.20^{b}
Daily Feed Consumption (g/bird)			
0 - 3 WK	1192.38±5.20	1191.75±7.35	1184.50±3.32
3 - 6 WK	3338.25±19.80	3348.88±25.77	3334.38±12.93
0 - 6 WK	4530.63±24.78	4540.63±20.84	4518.88±11.44
Feed Conversion Ratio (g feed / g gain)			
0 - 3 WK	1.37±0.021	1.35±0.019	1.41±0.019
3 - 6 WK	1.51±0.021^{b}	1.55±0.026^{b}	1.77±0.057^{a}
0 - 6 WK	1.47± 0.013^{b}	1.49±0.020^{b}	1.66±0.043^{a}

$^{a–b}$ Means with different superscripts in the same rows are significantly different (P ≤ 0.05). C= Control (continuous lighting) T1= Light Stimulation T2 =Intermittent Lighting

Carcass Criteria

The results of carcass criteria and some organs of chickens as affected by lighting programmes are presented in Table 3. The results in this Table showed no significant effects (P>0.05) in the most of carcass cut parts expect the neck and spleen%.

The neck (%) achieved the lowest (P≤0.05) value in birds exposed to C and T1 groups, while spleen % achieved the highest value in birds exposed to T1 and T2 groups compared to the control one. The obtained results disagree with the authors (El-Sagheer *et al.*, 2004, Fidan *et al.*, 2017, Soliman and Hassan 2019, Ghanima *et al.*, 2021 and Sodella and Gous 2022).

The influence of the light program comprising constant temperate photoperiod (LP1) (0 – 7d 23L: 1D, 8 – 39d 16L: 4D: 2L: 2D, 40 – 42d 23L: 1D) leads to an increase the carcass yield of broilers (Škrbić *et al.*, 2012). Breast muscle % of broilers kept on 12 L: 12 D achieved little percentage values as a result of the decrease in the period of feed consumption and the birds becomes not able to achieve growth potential (Brickett *et al.*, 2007). Chen *et al*. (2007) reported that there were no differences among lighting treatments (17 L: 7 D, 15 L: 9 D, 13 L: 11 D, 11 L: 11 D) in breast muscle % .Higher percentages of wings and legs observed in birds kept on the low density diet might be attributable to the birds being more active during the light phase (Balog *et al.*, 1997), and the wings and legs gaining more exercise to a certain degree.

Table3. Effect of lighting programme on carcass traits and some organs percentage of broiler chickens (X ±SE).

Traits	Treatments		
	(C)	(T1)	(T2)
Dressed, (including giblets)	78.21±0.92	77.82±0.47	77.56±1.00
Breast	34.01±1.71	34.26±0.97	33.97±2.35
Drum	10.53±0.67	10.95±0.78	11.80±0.79
Thigh	18.12±0.80	16.93±0.95	16.95±1.44
Back	17.91±0.84	18.18±0.25	16.07±1.02
Wings	10.21±0.37	9.43±0.24	9.10±0.42
Neck	2.62 ± 0.10^{b}	2.37 ± 0.10^{b}	3.48 ± 0.22^{a}
Organs %			
Spleen	0.12 ± 0.02^{b}	0.19 ± 0.02^{a}	0.19 ± 0.02^{a}
Gall bladder	0.16±0.01	0.16±0.01	0.13±0.01
Giblets			
Heart	0.40±0.03	0.41±0.04	0.36±0.02
Liver	2.18±0.18	2.09±0.06	2.32±0.25
Gizzard	1.29±0.10	1.07±0.04	1.19±0.09

a–b the same rows with different superscripts are significantly different (P ≤ 0.05).
C= Control (continuous lighting), T1= Light Stimulation, T2 =Intermittent Lighting.

Plumage Condition and Leg Problems

The results of the health condition of broiler chickens as affected by lighting programmes are presented in Table (4). No significant (P≥0.05) effects on breast blisters or leg problems due to lighting programs. However, these results agreed with Kristensen *et al*., (2006) and Renden *et al*., (1996), and

disagree with De Oliveira and Lara, (2016), Karaarslan and Nazlıgül, (2018) and Nelson *et al*., (2020).

Table 4. Effect of lighting programs on plumage condition and leg problems

Treatments	Breast blisters (score/1-5)	Leg problems (score/1-5)
(C)	4.10±0.09	1.05±0.03
(T1)	4.18±0.09	1.23±0.12
(T2)	4.13±0.08	1.13±0.08

C= Control (continuous lighting), T1= Light Stimulation, T2 =Intermittent Lighting.

Olanrewaju *et al.*, (2015) mentioned that the physiological responses of heavy weight broiler chickens and the blood gases, electrolytes, and metabolites are shallow in comparison, determination of these factors is essential in developing strategies that will enable to maximize production efficiencies and reducing the electricity consumption.

Conclusions

From the obtained results, it could be concluded that the application of a light stimulation programme for broiler chickens may improve the performance rate of broiler chickens and reducing electricity costs.

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دراسة تأثير بعض من برامج الإضاءة المختلفة على النمو التعويضي لدجاج تسمين اللحم

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قسم إنتاج الدواجن، كلية الزراعة، جامعة أسيوط، مصر.

الملخص

الهدف من هذه الدراسة هو معرفة تأثير استخدام بعض برامج الإضاءة المختلفة على الأداء الإنتاجي وصفات الذبيحة لدجاج تسمين اللحم. تم اختيار 120 (مائة وعشرون) كتكوت تسمين روس) عمر يوم عشوائياً في تجربة استمرت 6 أسابيع من العمر. تم استخدام ثلاث معاملات: الكنترول (إضاءة مستمرة طوال ال 24 ساعة)، برنامج تحفيز ضوئي، برنامج الإضاءة المتقطعة.

أشارت النتائج إلى وجود زيادة معنوية في وزن الجسم نتيجة تعرض الطيور لبرنامج التحفيز الضوئي والإضاءة المستمرة في عمر 3 و6 أسابيع، كما تحسن أيضا معدل الزيادة في وزن الجسم ومعدل التحويل الغذائي معنويا خلال الفترات من (3-6) و (0-6) أسابيع من العمر عند استخدام برنامج التحفيز الضوئي والإضاءة المستمرة ولا توجد أي اختلافات في الغذاء المستهلك.

وأوصت النتائج إلى أن استخدام برنامج التحفيز الضوئي يحسن من معدل أداء نمو كتاكيت اللحم ويقلل من تكلفة استهلاك الكهرباء.