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Effect of Lighting Program on Productive and Physiological Performance of Broiler Chicks

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ABSTRACT

The study was designed toinvestigate the effect of light schedule on growth performance, carcass traits and blood parameters of broiler chicks. Day-old-Cobb avian 48 broilers were allocated to 4experimental groups, each with 4 replications. All chicks were kept in floor pens. Birds were subjected to four light schedules: continuous light (control), 18 light (L):6 darkness (D), 17 h L: 7h D and 16h L: 8 h D. Scotoperiods were applied twice a night; the first at 7.00 p.m and the second at 5.00 am. Broiler growth performance, carcass traits, selected blood parameters and economic efficiency were estimated. It was observed that chicks exposed to 18h L: 6h D consumed more feed and had significantly higher body weight gain while feed conversion was unaffected compared with the control groups; the performance of other groups was comparable to that of the controls. Light schedule positively affected the economic efficiency but had no effect on carcass traits, except percent liver which was significantly higher in birds kept under 18h L: 6hD compared with the control ones. Light schedule did not affect plasma total protein or activity of transaminases but significantly affected plasma level of albumin, glucose, cholesterol, T3 or T4. In conclusion, use light schedules, 18 light (L): 6 darkness (D), showed best results for growth performance and Thyroid hormonal without any negative effect on other blood parameters

Keywords: Lighting programs, broiler performance.

INTRODUCTION

Light is one of the important factors for the production performance of broiler. So, the broiler producer must consider several critical factors in the design of lighting program to maximize growth rate, allow maximum feeding time and conscious feed consumption (Buyse*et al*., 1996 andLien *et al*. 2007).Many light programshave been applied to rear broiler chicks, such as continuous light, light (L) and dark (D) periods, and intermittent lighting programs. For many years, broiler chickens have usually been reared under continuous or almostcontinuous (23h L: 1h D) photoperiods to maximize feed consumption and growth rate (Mahmud *et al.,* 2011).

The aim of this study was to investigate the effects of lighting programs on productiveand physiological performance of broiler chicks.

MATERIALS AND METHODS

A total of 320 unsexed day-old Cobb broiler chickswere allotted to four experimental each with 4 replications. All chicks were kept in floor pens. Birds were subjected to four light schedules: continuous light (control), 18 light (L):6 darkness (D), 17 h L: 7h D and 16h L: 8 h D. Scotoperiods were applied twice a night; the first at 7.00 p.m and the second at 5.00 am. All chicks were kept under the same managerial, hygienic and environmental conditions and fed a commercial starter diet containing 22.4% crude protein and a metabolizable energy content of 2934kcal/kg diet during the period from day-old up to 21 days of age.From 21–35 days they received a commercial grower-finisher diet containing 21% crude protein and 3100kcal metabolizable energy /kg diet (Table 1).

The response of the chicks was assessed in terms of weekly body weights, feed intake and feed conversion. At the end of the experimental period (5 weeks of age), blood samples werecollected in heparinized test tubesfrom 4 chicks in each treatment group. The concentrations of plasma total protein (Doumas, 1975), albumin (Doumas*et al,*. 1971), cholesterol (Allain*et al.,* 1974), glucose (Trinder, 1969) weredetermined. The activities of serum aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were also determined according to the methods ofRietman and Frankel (1957).

Table (1): Composition and calculated analysis of the basal starter and finisher diets.

Ingredients %	Starter	Finisher
Yellow corn	60.50	58.50
Soybean meal (48 % CP)	30.80	35.30
Corn gluten meal	4.00	0.00
Vegetable oil	0.00	2.20
Ground limestone	1.40	1.80
Dicalciumphosphate	2.35	1.25
Common salt	0.35	0.35
Vit-Min. Permix*	0.30	0.30
DL-methionine	0.10	0.10
L-lysine-HCl	0.10	0.10
Coccidiostate	0.10	0.10
Total	100	100
Calculated chemical analysis*(NRC, 1994)*		
Crude protein, %	22.40	21.00
Metabolizable energy	2934	3100
(Kcal/kg)	1.11	1.01
Calcium, %	0.55	0.45
Available phosphorus, %	1.19	1.00
Lysine, %	0.47	0.42
Methionine, %	0.85	0.80
Meth. + Cys., %		

*** Premix at 0.30 of the diet supplies, the following per Kg of the diets :Vit. A 1000 I.U., Vit D3 2000 I.U., Vit E 10 mg, Vit K 1 mg, Vit B_1 5mg, Vit B_2 5mg, vit B_6 1.5 mg, Vit. B_{12} 0.01 mg, folic acid 0.35 mg, biotin 0.05 mg, pantothenic acid 10 mg, niacin 30 mg, choline 250 mg, Fe 30 mg, Zn 50 mg, Cu 4 mg and Se 0.1 mg.**

The colorimetric determination of thyroxine (T4) levels was carried out by double antibody radioimmunoassay (RIA) as described by Carew*et al.*

(1983). While triiodothyronine (T3) was analyzed by single antibody (RIA) with Gamma Coated RIA kits (Clinical Assays, Cambridge, MA). The T3/T4 ratio was calculated as indicator of the bioconversion rate of T4 to T3. At the end of the trial (5 weeks of age), 4 chicks from each treatmentgroup were sacrificed, scalded, de-feathered, and carcasses were eviscerated.Data on weights of dressing yields and abdominal fat pad were estimated. The heart, gizzard and liver were excised and weighed. The head and feet were removed, and the carcass weight was then determined. Carcass yield percentage was calculated by dividing the carcass weight plus giblets (liver, heart and gizzard) by live body weight of birds multiplied by 100. The economic efficiencyof the broiler production was calculated from input–output analysis.

Statistical analyses were done using one-way analysis of variance by the Statistical Analysis System (SAS, 1996).Significance of differences between treatment groups was determined using the Duncan's multiple range test (Duncan, 1955) at P≤0.05.

RESULTS AND DISCUSSION

Growth performance:

Growth performance parameters of broiler chicks as influenced by light Schedule are illustrated inTable 2.

As presented in Table 2,no significant differences in initial live body weights of broiler chicks subjected to different lighting programs, investigated here.At 35 days of age, chicks subjected to 18h L : 6h D achieved significantly heavier live body weigh compared with the control birds reread under continuous lighting.

The obtained results are in agreement with those reported byAbbas *et al.* (2008)who found that body weights for broiler received intermittent light (2h L:2h D) were significantly heavier by an average of 230g/bird as compared to the control group that received continuous light (23h L:1h D). In addition, Yildiz*et al.* (2009) showed that body weights of broilers receiving intermittent lighting (12 h daylight followed by 3 cycles of 1 h L, and then 3 h D during the night) were significantly higher (P≤ 0.05) than those receiving continuous lighting.Similarly,Çoban*et al.* (2014) found that the live body weights of broilers included in the continuous lighting (24h L: 0hD) and self-photoperiod groups (24h L: free choice for darkness) were higher significantly than those of birds included in the constant lighting group (16h L: 8hD). in harmony with the present results Parvu*et al*. (2014) reported that final live body weight and daily gain for broiler exposed to on intermittent program of 16h light (2h L: 1h D) and E2 with combined program of 18 h light (6L and six periodsof 2h L: 1h D) were insignificantly less than control group (a semi-continuous program, 23h L: 1h D).

Total body weight gain of chicks exposed to 18h L: 6h D was significantly higher (P≤0.05) compared with the control group kept under continuous lighting.

Our results are in disagreement with those found by Malone *et al*. (1980),who reported that the weight gained by the broiler when kept under an intermittent lighting program was significantly better than that of bird subjected to a continuous light. However,Mahmud *et al.* (2011) andOlanrewaju*et al.* (2012) didn't find any significant effect of lighting program on body weight gain of birds reared under the long/continuous (23L: 1D) and short/nonintermittent(8h L: 16h D) photoperiods.

Charles *et al.* (1992)reported that birds treated with increasing lighting program compared with birds under constant photoperiod; the higher plasma concentration of testosterone might be a contributing factor for enhancing growth rate of birds.

In addition, Buyse*et al.* (1996) argued that high plasma levels of growth hormone and insulin-like growth factor-I are causative factor for the observed improvement in nitrogen retention of male broilers raised under in intermittent lighting compared with their counterparts exposed to continuous lighting.

Feed intake:

The obtained results (Table 2) displayed that chicks kept under 18h L: 6h D consumed significantly more (P≤0.05) feed compared with their control ones. The increased feed intake of that group was the main reason for attaining higher body weight compared with the control group.

Our results are in agreement with those found by El Sabry*et al.* (2015), who reported that broilers reared under 14h L: 4h D followed by2hL: 4hD consumed slightly higher feed than control; (18h L: 6h D). But, Škrbić*et al.* (2012) and Çoban*et al.* (2014)found that lighting regimen had no significant effect of feed intake of broiler chicks.

Feed conversion:

As shown in Table 2, feed conversion of broilers for the whole experimental period (from one to 35 days of age) ranged between 1.64 by chicks exposed to18h L: 8h D and 1.72 by the control birds kept under continuous lighting with no significant differences among the different experimental groups.

It is interesting to note that birds kept under intermittent lighting programs, applied herein, and displayedslightly better means of feed conversion compared with the control ones raised under continuous lighting. This observed agrees with findings of Abbas *et al.* (2008) and Yildiz*et al.* (2009), who showed thatbroilers receiving intermittent lighting (12h daylight followed by 3 cycles of 1h light, and 3h dark during the night) had significantly better feed conversion ratios than those receiving continuous lighting (24h light:0h dark).Our results are in linealso with those found byBayram and Özkan (2010), Petek*et al.* (2010)and Çoban*et al.*(2014) who reported that feed conversion of broiler chicks.

The beneficial effect of darkness on feed conversion ratio of broiler exposed to intermittent lighting regimens. Providing longer dark periods increases the duration in which birds have lower metabolic rates, thereby reducing their energy requirements (Boon *et al.*, 2000 andClassen, 2004).

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. Such increases in jejunum length and villi width can lead to better digestion and utilization of nutrients. In addition, melatonin(a neurotransmitter produced in both the retina and the pineal gland of the chicken) is involved in the regulation of many circadian rhythms in the body, peaks during the dark period (Hau and Gwinner, 1994). Exogenous melatonin has been shown to result in the onset of sleep (Bermudez *et al.*, 1983).Another, other evidence has shown that the addition of exogenous melatonin to the diet of broilers results in reduced feed intake and an improvement in feed efficiency (Apeldoorn *et al.*, 1999)

Carcass traits:

Carcass traits of 5-week-old broilers as affected by light schedule are presented in Table 3.

Data given in Table 3 showed that there were no significant differences in all carcass traits examined, except liver percentage. The control group gave the least mean of liverpercentage when compared with T_2 but did not significantly differences than other treatments. It was observed that liver relative weight of chicks subjected to 18h L:6h D was significantly higher ($P \leq 0.05$) compared with that of the control group, but other light treatments were not significantly different from that of the control birds.

In the same trend, Çoban*et al.* (2014)found that lighting program had no effect on carcass characteristics of broiler chickens.On the other hand, Gornowicz and Lewko (2007)indicated that the intermittent light programs(4h L:2h D or 3h L:1h D) used in growing broiler chickens significantly increased slaughter yield; breast and leg muscles yield and decreased the amount of peritoneal fat in the carcasswhen compared with those of birds exposed to 23h L: 1h D. In addition Schwean-Lardner (2012) showed that relative weights of carcass and breast meat percentage increased by increasing day length (14h L , 17h L, 20h L to 23h L), but drum meat percentage was decreased with increasing day length.

Table (2): Effect of light schedule on growth performance of broiler chicks

Light Treatments	Initial Body weight (g) (day-old)	Body weight (g) 35 days old	Body weight (g) gain 1-35	Feed intake (g) 1-35	Feed conversion (g feed : g gain) 1-35
1	40.75	1862.50^{b}	1821.75^{b}	3136.50^{b}	1.72
2	40.00	2051.75^{a}	2011.75^{a}	3313.50^{a}	1.64
3	40.50	1895.00^{b}	1854.50^{b}	3141.00^{b}	1.69
4	40.00	1980.50^{ab}	1940.50^{ab}	3195.75^{b}	1.65
SEM	0.28	42.53	42.58	39.98	0.03
Sig. level	NS	**	**	**	NS

a-b:Means in the same column bearing common superscripts are not significantly different (P≤0.05).

Blood parameters:

Results of blood parametersof 5-week-old broiler as affected by light schedule are presented in Table 4.Results showed that light schedule, applied in this study, had no significant effect on plasma total protein or activity of transaminases (ALT and AST) in blood plasma of broiler chicks. But plasma levels of albumin, cholesterol, glucose, T3 and T4 were significantly affected by light schedule practiced here.

It was noticed that chicks subjected to 18h L: 6h D exhibited significantly lower level of plasma albumin (1.86 g/dl) compared with that of the control group (3.02 g/dl), other treatment groups were not significantly different from the control birds. Chicks kept under 18h L: 6h D, 17h L : 7h D or 16h L : 8h D displayed significantly higher ($P \leq 0.05$) plasma levels of glucose compared with that of the control group.

It was interesting to note that light schedule in which the chicks were exposed to 18h L : 6h D caused a significant reduction ($P \leq 0.05$) in serum cholesterol concentration. But birds kept under 16h L: 8h D exhibited significantly higher ($P \leq 0.05$) serum level of cholesterol compared with the control group. Also, significant increases ($P \leq 0.05$) were observed in serum levels of T3 and T4 of chicks reared under 18h L: 6h D or 17h L: 7h D as compared to their control counterparts.

The present results are in agreement with those found by Abbas *et al.* (2008),whoreported that broilers received intermittent light programs showed an increase in plasma T3 level as compared to the continuous light group. Scott (2002) showed that blood glucose for the broilers maintained under 16h constant light had consistently high levels while broilers maintained under constant 23 h lights had the lowest values.

But,Olanrewaju*et al.* (2013) reported that short/non-intermittent photo-periodsignificantlyreduced plasma levels of triiodothyronine and total protein when compared with long/continuous photoperiod. They added that, there were no effects of photoperiod on concentration of glucose and thyroxin in broiler.

Table (3): Effect of light schedule on carcass traits of 5-wk-old broiler chicks

Light Treatments	Body weight (g)	Carcass yield (%)	Breast Yield (%)	Thighs Yield (%)	Liver (%)	Heart (%)	Gizzard (%)	Giblets (%)	Abdominal Fat (%)
1	1839^{b}	73.41	39.81	29.33	2.57^{b}	0.45	1.24	4.26	1.47
2	2016^{a}	75.21	40.53	29.57	3.16^{a}	0.48	1.48	5.12	1.57
3	$1859a^{b}$	74.29	40.41	29.23	2.85^{ab}	0.45	1.36	4.66	1.24
4	1956^{a}	74.14	40.31	29.02	2.89^{ab}	0.45	1.27	4.59	1.12
SEM	115.01	0.37	1.45	1.31	0.32	0.004	0.19	0.35	0.25
Sig. level	**	NS	NS	NS	**	NS	NS	NS	NS

a-b:Means in the same column bearing common superscripts are not significantly different (P≤0.05).

Table (4): Effect of light schedule on blood plasma parameters of 5-wk-old broiler chicks

Light Treatments	ALT (U/l)	AST (U/l)	TP (g/dl)	ALB (g/dl)	CHOL (mg/dl)	Glucose (mg/dl)	T3 (ng/l)	T4 (ng/l)
1	31.76	26.29	5.90	3.02^{b}	127.06^{b}	128.75^{b}	1.42^{b}	5.75^{c}
2	31.79	28.46	6.34	3.86^{a}	98.62^{c}	190.00^{a}	5.35^{a}	15.35^{a}
3	30.79	26.40	5.88	2.40^{ab}	114.22^{b}	194.06^{a}	3.95^{a}	12.20^{b}
4	31.84	28.50	6.19	2.37^{ab}	147.24^{a}	185.62^{a}	2.24^{b}	10.10^{b}
SEM	0.81	1.52	0.43	0.24	29.03	25.37	0.46	0.72
Sig. level	NS	NS	NS	**	**	**	**	**

a-c:Means in the same column bearing common superscripts are not significantly different (P≤0.05).

Economic efficiency:

Data on economic efficiency of broiler as affected by light schedule are presented in Table 5.Results showed that the best value of economic efficiency was achieved by chicks exposed to 18h L: 6h D, followed by that of birds kept under 16h L: 8h D and the those reared under 17h L: 7h D. the control group display the least mean of economic efficiency.

Table (5): Economic efficiency of broilers subjected to different light schedules

Item Light Treatments	Total feed cost (L.E)	Total cost (L.E)	Total weight gain (g)	Total revenue (L.E)	Net revenue (L.E)	Economic efficiency (EE, %)	Relative E.E.
1	10.66	15.41	1824	29.2	13.77	89.4 ± 0.2^{d}	100
2	11.26	16.01	2017	32.3	16.26	101.5 ± 0.6^{a}	114
3	10.68	15.43	1854	29.7	14.23	92.2 ± 0.6^{c}	103
4	10.86	15.61	1940	31.0	15.43	98.8 ± 0.5^{b}	111

a-d:Means in the same column bearing common superscripts are not significantly different (P≤0.05).
Net revenue = Thedifference between price of weight gain and total cost of broiler production.
Economic efficiency = net revenue / total cost X 100

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تأثير نظم الإضاءة على الأداء الإنتاجى و الفسيولوجى فى كتاكيت التسمين

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أجريت هذه التجربة لتقدير تأثير نظم الاضاءة على الأداء الإنتاجى و صفات الذبيحة ومقاييس الدمفى كتاكيت التسمين، استخدم في الدراسه كتاكيت تسمين كوب ايفيان ٤٨ عمر يوم واحد وقسمت إلى ٤ مجاميع كلا منها تحتوى على ٤ مكررات.تم تربيه كل الكتاكيت تربية ارضية. وتعرضت الطيور لاربع برامج ضوئيه ١-: إضاءة مستمرة (المجموعة الحاكمة)٢- و١٨ ساعة إضاءة + ٦ ساعات إظلام ٣-و ١٧ ساعة إضاءة + ٧ ساعات إظلام٤-و ١٦ ساعة إضاءة + ٨ ساعات إظلام ،كانت فترة الإظلام مقسمة إلى فترتين تبدأ الأولى من السابعة مساءاً و تبدأ الثانية مناخامسة صباحاً، تم تقدير اداء نمو الطيور و صفات الذبيحة ومقاييس الدم المختارة و تم تقدير الكفاءة الاقتصادية للانتاج. وأظهرت النتائج أنالكتاكيت التى ربيت تحت نظام اضاءه ١٨ ساعة ضوء + ٦ ساعات إظلام استهلكت غذاءاً أكثر معنويا وحققت زياده معنويه عاليه في زياده وزن الجسم بينما لم يتأثر معامل التحويل الغذائى بالمقارنة بالمجموعة الحاكمة وكان أداء باقى المجموعات التجريبية متناسقاً مع المجموعة الحاكمة. أحدثت برامج الأضاءة تأثيراً إيجابياً على الكفاءة الاقتصادية للانتاج بينما لم يوثر معنويا على صفات الذبيحة عدا نسبة وزن الكبد الذى كان أعلي معنويافى الطيور التى ربيت تحت١٨ ساعة إضاءة + ٦ ساعات إظلام مقارنة بالمجموعة الحاكمة ، لم يكنلبرامج الإضاءة تأثير معنوي على نسبة البروتين الكلى فى بلازما الدم وكفاءة نشاط انزيمات الكبد بينما كان لها تاثير معنوي على مستوى كلا من الألبيومين و الجلوكوز و الكوليسترول وهرمون الثيرونين والثيروكسين في بلازما الدم. وقد خلصت الدراسة إلى أن استخدام برنامج إضاءة المتضمن ١٨ ساعة ضوء + ٦ ساعات إظلام يعطى أفضل النتائج من حيث الأداء الإنتاجى و مستوى هرموني الدرقية دون حدوث تأثير سلبى على باقى قياسات الدم.