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EFFECT OF INTERMITTENT LIGHTING ON THE PRODUCTION PERFORMANCE, LEG ABNORMALITIES, TOTAL MORTALITY RATE, AND SOME MICROBIAL TRAITS IN BROILERS CHICKEN

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ABSTRACT

This study was conducted at the field of poultry farm of the Department of Animal Production / College of Agriculture Engineering Sciences / University of Baghdad / Abu Ghraib during the period from 22/9-10/11/2019 (for a period of 49 days). This study aims to demonstrate the effect of different systems of lighting on production performance, leg abnormalities, total mortality rate and some microbial traits in broiler chickens. 300 un-sexed Ross308 chicks were used in the study with an average initial weight of 37.5 g. They were randomly distributed to five experimental treatments with three replicates for each treatment. Chicks were fed on starter diet for the first three weeks of age, and finisher diets for the fourth, fifth, sixth and seventh weeks of bird age. All birds switched to continuous lighting (24 hours light) during the first week of age. On the eighth day, the experiment was divided into five treatment, The first program was Tc (control) 24 hours of light, the second T1: 18 hours of light: 6 hours of darkness, and the third T2: 19 hours of light: 2 hours of darkness: 1 hour of light: 2 hours of darkness and the fourth T3: 17 hours of light: 3 hours of darkness : 1 hour of light: 3 hours of darkness, 5 hours of darkness, T4: 15 hours of light: 4 hours of darkness: 1 hour of light: 4 hours of darkness. (Up to the age of 6 weeks) and at the seventh week, all birds were exposed to continuous lighting for 24 hours of light. The results indicated that there were no significant differences in body weight, weight gain, feed consumption, feed conversion ratio. While, significant differences were observed in the percentage of leg abnormalities and total mortality, where the treatment of control Tc was highly significant ($P < 0.01$) in the incidence of leg abnormalities and the percentage of total mortality rate due to metabolic diseases(Ascites) and sudden death syndrome compared with all intermittent lighting programs. As it can be seen from the results, there was a high significant increase ($P < 0.01$) in the number of *Lactobacilli* bacteria in intermittent lighting treatments compared to the control treatment Tc in the crop, duodenum and the jejunum. The number of *E.coli* bacteria increased significantly ($P<0.01,0.05$)in the control treatment Tc compared with the intermittent light treatments in same character(crop, duodenum and the jejunum). conclusion: It is concluded from this study that intermittent lighting programs reduced the incidence of leg abnormalities, as well as reduced the mortality resulting from metabolic diseases such as (Ascites) and sudden death syndrome, and improved the microbial characteristics of the digestive system without affecting production performance.

Keyword: Intermittent light, leg abnormalities, microbial traits, mortality, Ascites, Broiler performance

Introduction

The continuous selection and phylogenetic improvement processes led to the production of new strains of broiler that are distinguished with rapid weight gain in a short period of time, and this improvement in growth led to the emergence of problems including the occurrence of leg abnormalities (rapid muscle growth due to skeletal development) and the spread of metabolic diseases such as Ascites, Sudden death syndrome (SDS), and insufficiency in the processes of the heart and circulatory processes, weakness in the lungs, decreased vitality and immunity, One way to counter these problems is to control the growth rate at the early age of the chicks, that allow organs such as the heart, lungs, and skeletal system to growth and development before the rapid formation of muscle tissue, as well as allows the chicks to mature anatomically at low rates of body weight and reduce proliferation diseases and metabolic disorders in addition to improving vitality and reduce the percentage of mortality due to ascites and sudden death syndrome, and all this is done by controlling lighting programs (optical rationing). Light blocking is considered a form of moderate feeding restriction, as these programs work in addition to reducing the early growth rate, they reduce feed consumption It improved the food conversion ratio (Donald *et al.*, 2000; Kleyn, 2002; Dibner *et al.*, 2007), and reducing electrical energy costs (Andrews and Zimmerman 1989 and Mahmud *et al.*, 2009). Lighting is considered an important environmental and management factor that affect the performance, welfare and production of broiler flocks (Deep *et al.*, 2010; Schwean-Lardner and Classen, 2010a; Attia *et al.*, 2011; Bovera *et al.*, 2013).

Several studies used a variety of lighting programs, which are continuous lighting for 23-24 hours, and intermittent lighting programs that contain two or more hours of light and darkness periodically within 24 hours. intermittent lighting programs can improve growth

performance, food conversion ratio, melatonin production, and improve elasticity of Bone, improving carcass characteristics, and reducing diseases associated with rapid growth, such as leg abnormalities, sudden death syndrome, and ascites in broilers, compared to the continuous lighting program, in addition to the intermittent lighting program (1 hour of light: 3 hours of darkness) periodically reduced the percentage of deaths and decreased levels of T_3 in plasma blood improves the quality of meat and increases muscle tissue (Hassanzadeh *et al*. 2003; Petek *et al*., 2005; Duve *et al*., 2011; Aviagen, 2014; Yang *et al*., 2015; Schwean-Lardner *et al*., 2016). This experiment was conducted to find out the effect of intermittent lighting on the productive characteristics and some microbial traits in broiler chickens.

Materials and Methods

300 broiler chicks at one day old of the Ross308 strain, un-sexed, with an average initial weight of 37.5 g, were prepared from the National Shukr hatchery to produce broiler chicks in the Abo Ghraib district. for the period from 22/9/2019 to 10/11/2019. The chicks were vaccinated against Newcastle and infectious bronchitis diseases with water. They were randomly distributed to five experimental treatments with three replicates for each treatment. Chicks were fed on starter diet(pellet) for the first three weeks of bird age (1-21 days of age, 22.3% P., 3000Kcl E.), and finisher diets for the fourth, fifth, sixth and seventh weeks of bird age (22-49 days of age, 21.4% P., 3100Kcl E.) (Table1). All birds switched to continuous lighting (24 hours light) during the first week of age. On the eighth day, the experiment was divided into five treatment ,The first program was Tc (control) 24 hours of light, the second T1: 18 hours of light: 6 hours of darkness, and the third T2: 19 hours of light: 2 hours of darkness: 1 hour of light: 2 hours of darkness and the fourth T3: 17 hours of light: 3 hours of darkness : 1 hour of light: 3 hours of darkness, 5 hours of darkness, T4: 15 hours of light: 4 hours of darkness: 1 hour of light: 4 hours of darkness. (Up to the age of 6 weeks) and at the seventh week, all birds were exposed to continuous lighting for 24 hours of light. Weights of birds were recorded weekly, and total weight gain was calculated, the amount of feed consumption and the food conversion ratio(FCR), in addition to the Calculating the numbers of lactobacilli and coliform bacteria in the contents of the crop, duodenum and jejunum by Taking 1 gm of the contents of the crop, duodenum and jejunum of three birds slaughtered for each treatment at the end of the experiment, separately in sterile conditions and next to the flame, and decimal dilutions were made from them up to 10^{-10} dilutions using sterile peptone water for the purpose of estimating the numbers of the following microorganisms:-

1. Calculating the number of lactobacilli bacteria

After the micropipate decimal dilution was performed, the number of lactobacilli was estimated by the Pou - plate method mentioned by Harrigan and MacCance (1976) by transferring 1 ml of each decimal diluent into two layers of empty and sterile Petri dishes (Duplicate). Immediately, 15 ml of the sterilized, sterile MRS Agar culture medium was added immediately to each plate and kept in a 46 °C water bath. Mitigation. After hardening the plates, they were placed in the anaerobic container at 37 °C for a period of 48 hours, and then the numbers of developing colonies were calculated by multiplying the number of colonies x the reciprocal of the dilution.

2. Calculate the number of coliform bacteria

The number of coliform bacteria was calculated as in the case of counting lactobacilli, but when 1 ml of each decimal diluent was transferred to two sterile Petri dishes directly, 15 ml of the sterile Macconkey Agar was added to each dish, and after hardening of the culture medium in the plates, it was kept inverted at 37 °C 0 For a period of 48 hours after that, the colonies developing in the plates were counted as mentioned above

Statistical Analysis

Data were analyzed statistically by ANOVA using a completely randomized design (CRD). In case of significance difference, multiple range test was used (Duncn, 1955). Statistical software (SAS, 2013) was used to carry out statistical analysis.

Results

Table 2 shows the effect of continuous and intermittent lighting on the average live body weight. It is noticed that there were no significant differences between all five experimental treatments at Weeks 1, 2 and 4. While treatment T2 was significantly superior ($P < 0.05$) compared with treatments T1 and T3 at the age of three weeks, but it did not differ significantly with treatment Tc and treatment T4, and there were no significant differences between the control treatment and the treatments T1, T3 and T4 at the same age. In the fifth week, treatment T2 recorded a highly significant($P<0.05$) compared to the control treatment and all trial treatments, while no significant differences were observed between the control treatment Tc and the treatments T1, T3 and T4. Treatment T2 also significantly ($P<0.05$) compared with the two treatments T3 and T4, While it was not significantly different with the control treatment Tc and T1 in the sixth week of age. Treatment T2 also significantly ($P<0.05$) compared with treatment T4, while there were no significant differences between it and the control treatment Tc and the two treatments T1, T3, and the control treatment Tc did not differences compared with the treatments T1, T3, T4 at the seventh week of age.

It is noted from Table 3 the results of the effect of continuous and intermittent lighting in the average of weekly and total weight gain of broilers, which indicate that continuous and intermittent lighting programs had no significant effect at weeks 1, 2 and 4 of age. While there was a significant superiority ($P < 0.05$) for the treatment T2 compared with the treatment T3 in the third week, and there was no difference with the control treatment Tc and the two treatments T1 and T4. The treatment of control Tc did not differ with the treatments T1, T3 and T4 at the same age. In the fifth week, it was found that there was a significant superiority ($P < 0.05$) for the treatment T2 compared with the control treatment Tc and the two treatments T3 and T4, while it did not differ significantly with the treatment T1, and there were no significant differences between the control treatment and the treatments T1, 3T and T4, while it was found that there were no significant differences between all the treatments in the Sixth week. The results indicate a significant improvement for T1 and T3, T2 treatments compared with T4 treatment in the average weekly weight gain. These treatments did not differences significantly

compared with the control treatment, and T4 treatment did not differences significantly with the control Tc treatment at the seventh week of age. As for the total weight gain increase, treatment T2 showed significant superiority (P <0.05) compared with treatments T3 and T4, and it did not differences with the control treatment Tc and T1 treatment, and the control treatment did not difference significantly with the rest of the experimental treatments for the period from 0-6 weeks. Treatment T2 also significant difference with the treatment T4, while it did not difference with the treatments Tc, T1 and T3, and the treatment T4 did not difference with the treatments Tc, T1 and T3 in the average of total weight gain increase for the period from 0-7 weeks.

Table 1 : The chemical composition of the starter and finisher diets

Chemical composition *	Starter diets (1-21 days)	Finisher diets (22-35 days)
Crude protein (%)	22.3	21.4
Representative energy (kcl / kg feed)	3000	3100
Crude fiber (%)	2.5	3.3
Fats (%)	3.6	6.3
Ash (%)	5.5	5.0
Phosphorous (%)	0.46	0.69
Sodium (%)	0.20	0.18
Calcium (%)	1.00	0.88
Methionine (%)	0.66	0.50
Lysine (%)	1.35	1.32

* Based on the identification tag (label) attached to the used feed bags

Table 2 : The effect of continuous and intermittent lighting on average weekly live body weight (gm) of broilers for the period from 0-7 weeks (mean ± standard error).

Age week	Tc(1)	T1	T2	T3	T4	Significance(3)
1	191.42±3.578	195.333±0.741	190.583±9.544	185.333±2.994	198.917±12.275	N.S
2	509.667±9.399	510.00±15.092	513.670±13.976	522.500±17.859	492.833±18.939	N.S
3	944.00±10.681^{ab}	931.100±16.053^{b}	980.100±11.265^{a}	933.467±b7.086	939.00±16.289^{ab}	*
4	1602.36±24.83	1600.17±25.542	1676.03±12.996	1612.01±8.561	1645.61±33.357	N.S
5	2245.08±32.629^{b}	2262.985±5.671$^{b(2)}$	2407.35±36.271^{a}	2245.28±13.495^{b}	2224.29±54.357^{b}	*
6	3028.68±43.090^{ab}	3050.96±68.243^{ab}	3179.38±23.695^{a}	3004.79±1.551^{b}	2997.87±61.903^{b}	*
7	3641.25±66.89^{ab}	3783.72±131.279^{ab}	3890.20±35.122^{a}	3705.75±11.932^{ab}	3499.94±167.037^{b}	*

(1)Tc:24 hours light, T1:18 hours light: 6 hours darkness,T2:19 hours light:2 hours darkness:1 hour light:2hours darkness, T3:17 hours light: 3 hours darkness:1hour light:3 hours darkness, T4:15hours light: 4 hours darkness:1hour light:4 hours darkness. (2)The different letters within the same row indicate significant differences between the averages. (3) N.S was no significant difference. * There was a significant difference at P <0.05.

Table 3 : The effect of continuous and intermittent lighting on the average weekly and total weight gain (gm / bird) of broilers for the period from 0-7 weeks (mean ± standard error).

Age week	Tc(1)	T1	T2	T3	T4	Significance(3)
1	153.917 ±4.355	158.833 ±0.220	154.083±9.542	150.00 ±3.437	161.250 ±11.861	N.S
2	318.250±5.822	314.667±15.485	323.087±18.004	337.167±15.074	293.917± 8.794	N.S
3	434.333±1.884^{ab}	421.100±23.406^{ab}	466.263±2.802^{a}	411.083±18.741^{b}	446.167±6.585^{ab}	*
4	658.360 ±23.905	669.070±10.762	695.867 ±5.535	670.677 ±9.051	706.607±18.679	N.S
5	642.723±9.167^{bc}	662.810±32.232^{ab}	731.317±28.501^{a}	633.270±9.450^{bc}	578.687±27.740^{c}	*
6	783.597±10.854	787.980±46.382	772.033±42.195	759.510±14.941	773.573±30.132	N.S
7	612.567±38.553^{ab}	732.763±68.446$^{a(2)}$	710.833±17.414	700.957±10.409^{a}	502.070±105.500^{b}	*
0-6	2991.18±44.382^{ab}	3014.46±67.725^{ab}	3142.65±23.845^{a}	2961.71±5.544^{b}	2960.20 ±61.463^{b}	*
0-7	3603.75±68.134^{ab}	3747.22±130.710^{ab}	3853.48±35.158^{a}	3662.66 ±4.933^{ab}	3462.27±166.596^{b}	*

(1) Tc:24 hours light, T1:18 hours light: 6 hours darkness,T2:19 hours light:2 hours darkness:1 hour light:2hours darkness, T3:17 hours light: 3 hours darkness:1hour light:3 hours darkness,T4:15hours light: 4 hours darkness:1hour light:4 hours darkness. (2)The different letters within the same row indicate significant differences between the averages. (3)N.S was no significant difference. * There was a significant difference at P <0.05.

Table 4 shows the effect of continuous and intermittent lighting on the weekly and total feed consumption of broilers, it was found that were no significant differences in the first week of age. While treatment T2 was significantly superior (P <0.05) compared with treatments Tc and T1, while it did not difference significantly with treatments T3 and T4, the control treatment did not difference significantly with treatments T1, T3 and T4 in the second week. Also, treatment T2 recorded significant superiority (P <0.05) compared with the control treatment Tc and the all of the experimental treatments in the third week, while there were no significant differences between the control treatment and

the T1, T3 and T4 treatments at the same age. In the fourth week, the treatment T1 showed a significant decrease (P <0.05) compared with treatment T2 and did not difference with the treatments Tc, T3 and T4, and no significant differences were found between the control treatment and the two treatments T3 and T4, while the control treatment recorded a significant decrease compared with treatment T2. In the fifth week, treatment T4 recorded a significant decrease (P <0.05) compared with treatment T2, while there were no significant differences between it and the treatments Tc,T1 and T3, and there were no significant differences between the control treatment Tc and the two treatments T1 and T3. It is also noticed that there are no significant differences between all experimental treatments at the age of 6 weeks, but at the seventh week, the table indicates the superiority of treatment T2 significantly (P <0.05) compared with treatment Tc and T4 and did not difference with the treatments T1 and T3, and the control treatment did not difference compared with the treatments T1, T3 and T4. It is evident from the table that the total feed consumption (0-6 weeks) indicates that the treatment T2 was significantly superior (P <0.05) compared with the control treatment while it did not difference with the treatments T1, T3 and T4, and the control treatment did not difference significantly compared with the treatments T1, T3 and T4. In total (0-7 weeks), the two treatments Tc and T4 recorded a significant decrease (P <0.05) compared with treatment T2, while there were no significant differences between the treatments T1, T2 and T3, and the two treatments Tc and T4 did not difference significantly compared with the treatments T1 and T3 for the same time period.

The results shown in Table 5 indicate the effect of continuous and intermittent lighting on the weekly and total feed conversion ratio of broilers, as it is noticed that there is no significant difference between all the experimental treatments at weeks 1, 2, 3 and 6 of age, while the treatments T4 and T1 recorded a significant improvement (P <0.05) compared with Treatment T3, which did not difference with the control treatment and treatment T2, as there were no significant differences between the control treatment and all trial treatments at 4 weeks of age. A high significant improvement (P <0.01) was observed in treatment T2 compared with treatments Tc, T1, T3 and T4 at the fifth week, while there were no differences between the control treatment and the treatments T1, T3 and T4 at the same age, while it was noticed from the table that a significant improvement (P <0.05) occurred for the treatments T1, T2 and T3 compared with treatment T4, while There were no significant differences compared with the control treatment, and the control treatment did not significantly difference from the T4 treatment at the seventh week. As for the total feed conversion ratio (0-6 weeks), the control treatment recorded a significant improvement (P <0.05) compared with the two treatments T3 and T4, while it did not difference significantly with the two treatments T1 and T2, while a significant increase (P <0.05) was observed in the value of feed conversion ratio of treatment T4 compared with treatments Tc, T1 and T2, while there were no significant differences with treatment T3 when calculating the total feed conversion ratio (0-7 weeks).

Table 6 shows the effect of continuous and intermittent lighting in the treatment of leg abnormalities and mortality to the increase of leg abnormalities in the treatment Tc high significant P<0.01 compared with all the intermittent lighting treatments, and a significant increase in the total mortality percentage in the treatment of control Tc compared with the treatments T1 and T2, while no differences were found with T3 and T4 coefficients, as there were no significant differences between all intermittent light treatments.

Table 4 : The effect of continuous and intermittent lighting on the weekly and total feed consumption (gm / bird) of broilers for the period from 0-7 weeks (mean ± standard error).

Age week	Tc(1)	T1	T2	T3	T4	Significance(3)
1	145.667±12.073	153.167±1.121	154.583±2.042	153.833±3.901	162.250±5.019	N.S
2	315.00±9.409 b	312.750±9.042 b	341.250±6.002 a	336.167±2.949 ab	321.167±5.606 ab	*
3	563.833±8.996 b	565.583±10.011 b	600.333±5.364 a	571.167±2.973 b	570.083±9.215 b	*
4	886.487±27.282 b	885.437±6.533b(2)	954.897±20.707 a	918.500±1.983 ab	932.540±20.244 ab	*
5	1081.92±18.745 ab	1109.12±42.438 ab	1143.49±28.296 a	1093.56±25.975 ab	1013.59±35.168 b	*
6	1164.12±60.090	1227.10±62.631	1238.63±16.177	1230.27±31.725	1247.29±38.397	N.S
7	1339.80±32.728 b	1426.42±54.695 ab	1486.30±21.350 a	1404.18±18.107 ab	1334.55±63.206 b	*
0-6	4157.03±93.236 b	4253±54.887 ab	4433.19±27.554 a	4303.50±9.997 ab	4246.93±86.819 ab	*
0-7	5496.83±125.946 b	5679.58±98.814 ab	5909.49±41.99 a	5707.68±28.09 ab	5581.47±137.395 b	*

(1)Tc:24 hours light, T1:18 hours light: 6 hours darkness,T2:19 hours light:2 hours darkness:1 hour light:2hours darkness, T3:17 hours light: 3 hours darkness:1hour light:3 hours darkness,T4:15hours light: 4 hours darkness:1hour light:4 hours darkness. (2)The different letters within the same row indicate significant differences between the averages. (3)N.S was no significant difference. * There was a significant difference at P <0.05.

Table 7 indicates the effect of continuous and intermittent lighting on the numbers of lactobacilli and coliform bacteria in the crop, duodenum and jejunum, it is explicit that a high significant P <0.01 in the numbers of lactobacilli bacteria in the vesicle was obtained in all intermittent lighting treatments compared with the control treatment (Tc) while there was no Significant differences between the intermittent light treatments (T1, T2, T3, T4). As for coliform bacteria in the crop, the numbers of these bacteria in the control treatment Tc increased significantly (P<0.01) compared to the intermittent light treatments, and there were no differences between T1, T2, T3 and T4 in the same traits.

It is also evident from the table also that there was a significant increase in the number of lactobacilli, P <0.01, in the twelve in all intermittent lighting treatments compared with the control treatment. As for coliform bacteria in the duodenum, the control treatment recorded a high significant increase (P <0.01) compared to with the intermittent light treatment, there were no significant differences between the intermittent light treatment in the same characteristic. The

table also shows that there was a significant increase, P <0.01, in the number of lactobacilli bacteria in the jejunum in all of the intermittent lighting treatments compared with the control treatment. Treatment T1 and T2 were significantly higher than with T3 and T4 in the same characteristic. As for coliform bacteria in the jejunum, treatment T1 and T2 recorded a significant decrease P <0.05 in the number of coliform bacteria compared to the control treatment, while the numbers of these bacteria did not differ significantly between the control treatment and the treatments T3 and T4.

Table 5 : The effect of continuous and intermittent lighting on the weekly and total feed conversion ratio (gm feed / gm weight gain) for broilers for the period from 0-7 weeks (mean ± standard error)

Age week	Tc(1)	T1	T2	T3	T4	Significance(3)
1	0.943±0.054	0.963±0.007	1.007±0.047	1.023±0.017	1.011±0.048	N.S
2	0.987±0.018	0.995±0.035	1.060±0.044	1.00±0.049	1.090±0.015	N.S
3	1.297±0.019	1.347±0.054	1.287±0.019	1.357±0.068	1.277±0.031	N.S
4	1.343±0.009^{ab}	1.323±0.013$^{b(2)}$	1.357±0.003^{ab}	1.367±0.022^{a}	1.317±0.009^{b}	*
5	1.683±0.015^{a}	1.670±0.035^{a}	1.563±0.022^{b}	1.720±0.029^{a}	1.747±0.023^{a}	**
6	1.487±0.085	1.557±0.019	1.610±0.071	1.617±0.015	1.613±0.027	N.S
7	2.193±0.103^{ab}	1.967±0.118^{b}	2.090±0.055^{b}	2.00±0.032^{b}	2.840±0.443^{a}	*
0-6	1.290±0.0162^{b}	1.309±0.011^{ab}	1.314±0.014^{ab}	1.347±0.006^{a}	1.342±0.006^{a}	*
0-7	1.523±0.006^{b}	1.513±0.027^{b}	1.530±0.020^{b}	1.553±0.009^{ab}	1.613±0.042^{a}	*

(1)Tc:24 hours light, T1:18 hours light: 6 hours darkness,T2:19 hours light:2 hours darkness:1 hour light:2hours darkness, T3:17 hours light: 3 hours darkness:1hour light:3 hours darkness, T4:15hours light: 4 hours darkness:1hour light:4 hours darkness. (2)The different letters within the same row indicate significant differences between the averages. (3)N.S was no significant difference. * There was a significant difference at P <0.05.** There was a significant difference at P<0.01

Table 6 : The effect of continuous and intermittent lighting on leg abnormalities and total mortality rate of broilers at 7 weeks of age (mean ± standard error).

Traits / Treatment	Leg abnormalities	Mortality(%)
Tc(1)	1.000±0^{a}	1.667±0.333^{a}
T1	0.000±0$^{b(2)}$	0.333±0.333^{b}
T2	0.000±0^{b}	0.333±0.333^{b}
T3	0.000±0^{b}	0.667±0.333^{ab}
T4	0.000±0^{b}	0.667±0.333^{ab}
Significance(3)	**	*

(1)Tc:24 hours light, T1:18 hours light: 6 hours darkness,T2:19 hours light:2 hours darkness:1 hour light:2hours darkness, T3:17 hours light: 3 hours darkness:1hour light:3 hours darkness, T4:15hours light: 4 hours darkness:1hour light:4 hours darkness. (2)The different letters within the same row indicate significant differences between the averages. (3)N.S was no significant difference. * There was a significant difference at P <0.05.** There was a significant difference at P<0.01

Table 7 : The effect of continuous and intermittent lighting on the number of lactobacilli and E. coli bacteria (logarithm) in the crop, duodenum and jejunum at 7 weeks of age (mean ± standard error)

	Crop		Duodenum		Jejunum	
Traits / Treatment	*Lactobacillus* bacteria (logarith)	*E.coli* bacteria (logarithm)	*Lactobacillus* bacteria (logarith)	*E.coli* bacteria (logarith)	*Lactobacillus* bacteria (logarith)	*E.coli* bacteria (logarith)
Tc	6.620±0.211^{d}	5.483±0.147^{a}	7.070±0.031^{b}	5.183 ± 0.095^{a}	6.716±0.314^{c}	5.266±0.138^{a}
T1	8.796 ±0.119^{c}	4.300±0.132^{b}	9.933± 0.022^{a}	4.126±0.054^{b}	8.876±0.035^{a}	4.196±0.038^{c}
T2	9.266 ±0.027^{b}	4.146 ±0.296^{b}	9.536±0.211^{a}	4.226±0.054^{b}	8.610±0.280^{a}	4.590±0.036^{bc}
T3	9.736 ±0.113^{a}	4.083 ±0.027^{b}	9.820± 0.101^{a}	4.163±0.043^{b}	7.913±0.019^{b}	4.750±0.374^{abc}
T4	9.756 ±0.028^{a}	4.070 ±0.031^{b}	9.513±0.299^{a}	4.273±0.321^{b}	7.840±0.070^{b}	4.820±0.006^{ab}
Significance(3)	**	**	**	**	**	*

(1)Tc:24 hours light, T1:18 hours light: 6 hours darkness,T2:19 hours light:2 hours darkness:1 hour light:2hours darkness, T3:17 hours light: 3 hours darkness:1hour light:3 hours darkness, T4:15hours light: 4 hours darkness:1hour light:4 hours darkness. (2)The different letters within the same row indicate significant differences between the averages. (3)N.S was no significant difference. * There was a significant difference at P <0.05.** There was a significant difference at P<0.01

Discussion

Tables (2, 3) show that there are no significant differences between intermittent lighting treatments and continuous lighting treatments (control) in the average live body weight and total weight gain at 7 weeks of age. These results were in agreement with Bayram and Ozkan (2010); Petek *et al*. (2010); Amakiri *et al*. (2011); Olanrewaju *et al*. (2012); Mosleh *et al*. (2014) whose results indicated that there was no significant effect of different lighting systems on live body weight and average weight gain in broilers As for the total feed consumption, it was found a significant superiority (P <0.05) in some intermittent lighting treatments (T2 treatment) for the period 0-6 and 0-7 weeks in addition to the mathematical superiority of the two periods above for all

the intermittent lighting treatments compared to the control treatment (Table 4), The reason for this especially in treatment T2 (19 hours light: 1 hour darkness: 2 hours light: 2 hours darkness) is due to the increase in the number of hours of light and the decrease in the number of hours of darkness, which leads to an increase in the consumption of feed and increase in body weight and weight gain. Othani and Tanaka (1998) explained The birds that were exposed to long periods of darkness went to the feeders vigorously and high speed at one time to devour the largest amount of feed when the lights were returned, while the birds that were exposed to constant lighting showed less concern and activity because of their continued consumption of feed. The same researcher concluded that the upper part The digestive tract may be empty in birds that have been exposed to periods of darkness and therefore ready to consume feed when the lighting returns, which led to an increase in feed consumption. indicated May and Lott (1994) and Schwean-Lardner (2014) indicated the highest level of consumption feed is immediately after the return of the lights in response to hunger and before turning off the lights in anticipation of the absence of feed during the dark period. These results are in agreement with those obtained by Brown (2010); Olanrewaju *et al*. (2012); Assaf *et al*. (2016); Fidan *et al*. (2017) whose results indicated that there were no significant differences in average of total feed consumption when using continuous and intermittent lighting programs. feed conversion ratio, (Table5) indicates no significant differences in the total feed conversion ratio between the continuous lighting program (control) and the intermittent lighting programs except treatment (T4). The results of this study are in agreement with the results of Bayram and Ozkan (2010); Olanrewaju *et al*. (2012, 2018, 2019), whose studies showed that there were no significant differences in the feed conversion ratio when using continuous and intermittent lighting programs. The reason for the increase in feed conversion ratio in the treatment T4 is due to the decrease in the average body weight mathematically but not significant compared to the control treatment. It is noticed from (Table 6) there was a high significant increase ($P < 0.01$) in the percentage of leg abnormalities when using the continuous lighting program compared to the intermittent lighting programs. The reason for this may be attributed to the consumption of feed continuously and to the rapid growth and development of tissues and muscles in the early ages, It increases body mass at the expense of the development of the skeleton, which is unable to support the body (Donald *et al*., 2000). Schwean-Lardner *et al*. (2010b) explained that the production of melatonin is less in birds exposed to long light periods, which affects the absorption and deposition of calcium in the bones, especially the leg bones, compared with birds that are exposed to long periods of darkness. Where it has been shown that the secretion of melatonin is abundant in the dark period, which coincides with a decrease in energy spent on physical activity, as melatonin plays an important role in the performance of growth and activation of immune cytokines (Apeldoorn *et al*., 1999). The results of this study are in agreement with Bayram and Ozkan (2010); Tuleun *et al*., (2010); Skrbic *et al*. (2015); Yang *et al*. (2015) who indicated that intermittent lighting programs reduced the incidence of leg abnormalities and improved leg health, while this results differed with Onbasilar *et al*. (2007); Van der Pol and others (2017) who noted that different lighting programs had no significant effect in reducing leg abnormalities and improving leg health. total mortality rate, it is noticed in the same table the treatment of continuous lighting was higher in the percentage of mortality resulting from (Ascites) and sudden death syndrome compared with intermittent lighting programs, which are due to an increase in the rate of metabolism and an increase in the rapid growth, which requires increased oxygen requirements. This is due to the continuous lighting, which leads to an increase in pulmonary blood pressure due to pumping large quantities of blood to obtain the necessary oxygen to produce the energy needed to complete the metabolic processes that lead to hypertrophy in the right ventricle and the occurrence of ascites or sudden death (Hassanzadeh *et al*., 2000 and Gupta, 2011). These results were in agreement with Hassanzadeh *et al*. (2003, 2005, 2012), Schwean-Lardner *et al*. (2013) who result indicated that intermittent lighting programs reduced the percentage of total mortality due to ascites and sudden death compared with the Continuous lighting program. While different with Ozkan *et al.* (2012); Olanrewaju *et al*. (2018) reported that there were no significant differences in the percentage of mortality when using different lighting programs. The reason for the significant increase in the number of lactobacilli bacteria in the crop, duodenum and the jejunum in all intermittent light treatments (Table 7) may be attributed to the increase in the processes of digestion and absorption due to the increase in the number of dark hours in these treatments compared with the control treatment. Cutler *et al*. (2005) also explained that increased feed storage in the crop and the high synthesis of fermentation products by lactobacilli in the crop reduces pH, which is the appropriate environment for the proliferation of lactobacilli bacteria. As the abundance of lactobacilli bacteria in the follicle lowers the pH due to the production of organic acids (Fuller, 2001) as the organic acids produced by the bacteria present in the follicle have a positive effect on the intestine and the health of the mucous membrane and can prevent colonization of harmful bacteria such as E. coli and Salmonella. ssp as this effect was not only in the crop, but it was in the liver and spleen (Ricke, 2003; Fonseca *et al.*, 2010; Ptak *et al.*, 2015; Witzig *et al*., 2015). These treatments also recorded a significant decrease in E. coli bacteria compared to Control treatment. These results were in agreement with Classen *et al*. (2016) who concluded that the crop plays an important role in the performance and health of poultry and that is through the early establishment of lactobacilli in it and the provision of the active substance necessary for fermentation through the organized storage of feed in the crop, which is done through the use of lighting programs. And use of probiotics and exogenous enzymes as they indicated that a mixture of multiple and site-specific bacterial strains would be needed to expand the beneficial effects throughout the gut.

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