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EFFECT OF INTERMITTENT LIGHT ON BROILER CHICKS PERFORMANCE

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ABSTRACT

The effect of lighting pattern on mortality, live body weight, growth, food intake, food conversion ratio and crop and gizzard mass were evaluated in this experiment. Six hundred broiler chicks of one day old were reared on wood shaving litter floors in light controlled chambers. Five chambers were randomly assigned to each of the five light treatments: ***group 1****- 23L (light): 1D (dark) from day 1 to day 7 then followed by 18L: 6D from day 8 to day 14 and 13L: 11D from day 15 to day 21 and an intermittent light pattern 5L: 3D from day 22 to slaughter;* ***group 2****- 23L: 1D from one day old to day 20 of age, an intermittent light pattern of 5L: 3D from day 21 to slaughter;* ***group 4****- 23L: 1D from day 1 to day 7 then followed by 18L: 6D from day 8 to day 14 and 13L: 11D from day 15 to day 21 and 3L: 5D from day 22 to slaughter;* ***group 5****- 23L: 1D from one day old to day 20 of age, an intermittent light pattern of 3L: 5D from day 21 to slaughter and* ***control- group 3****-23L: 1D from one day old till slaughter. Insignificant differences (P> 0,05) between treatments were obtained in live body weight at 20, 30 and 37 days of age but group 1 presented the highest average (2149,6 ±103,3 g) at the end of the experiment. In the same manner, this group established the highest percentage of increased body weight gain (+ 31,4%) related to control group. Data obtained on mortality, feed in-*

take and feed conversion ratio showed no significant difference (P>0,05), but groups 1, 2 and 4 had the lowest percentage of mortality while group 1 presented the best food conversion ratio (2,04). Weights of crop and gizzard contents as well as crop and gizzard tissue mass at the beginning of the dark and light periods were not significantly different (P>0,05) among treatments. However, when comparing results obtained within the same treatment, a significant difference (P<0,05) between crop contents at the beginning of the light period and those at the beginning of the dark period of group 1 (2 ± 1,63g vs 25,2 ± 16,52g, respectively) was observed. These results suggested that the scheme used in group 1 was the best.

Key words: *broiler, light pattern, live body weight, weight gain, crop and gizzard mass, food conversion ratio.*

RÉSUMÉ

Une expérience a été menée durant les mois de septembre et octobre 2003 à la ferme expérimentale de l'Université Saint Esprit de Kaslik – Maounet, Jbeil afin d'évaluer l'effet de la lumière sur le poids des poulets de chair, le gain de poids, la mortalité, la consommation de nourriture et son taux de conversion ainsi que son effet sur le contenu du jabot et du gésier. Six cents poussins âgés d'un jour ont été répartis au hasard en 5 groupes recevant chacun un système d'éclairage différent. Les systèmes utilisés sont : ***groupe 1-*** *une photopériode de 23h/24h du jour 1 au jour 7 suivi par 18h/24h du jour 8 au jour 14 et 13h/24h du jour 15 au jour 21 et 5L: 3D du jour 22 jusqu'à l'abattage;* ***groupe 2-*** *une photopériode de 23h/24h du jour 1 au jour 20 suivi par un modèle de lumière intermittent de 5L: 3D du jour 21 jusqu'à l'abattage;* ***groupe 4-*** *une photopériode de 23h/24h du jour 1 au jour 7 suivi par 18h/24h du jour 8 au jour 14 et 13h/24h du jour 15 au jour 21 et 3L: 5D du jour 22 jusqu'à l'abattage;* ***groupe 5-*** *une photopériode de 23h/24h du jour 1 au jour 20, un modèle intermittent de 3L: 5D du jour 21 jusqu'à l'abattage et* ***groupe*** *3– témoin une photopériode de 23h/24h du jour 1 jusqu'à l'abattage. L'alimentation des poulets a été divisée en 3 phases principales. Ils ont été nourris avec des rations basées sur un mélange de maïs et graine de soja fournissant dans chaque étape le même niveau de protéine pour tous les groupes. Les résultats obtenus sur le poids au $10^{ième}$, $20^{ième}$, $30^{ième}$ et $37^{ième}$ jours d'âge n'ont montré aucune différence significative (P>0,05) entre les traitements. A l'abattage, le groupe 1 a présenté un poids supérieur (2149,6± 103,3 g) bien que sans différence significative. Ce groupe a aussi présenté le gain de poids (+ 31,4%) le plus élevé apparenté au groupe témoin. Bien qu'aucune différence significative (P>0,05) concernant la morta-*

lité, la consommation et le taux de conversion de nourriture n'a été obtenue, les groupes 1, 2 et 4 avaient le pourcentage de mortalité le plus bas. Par ailleurs, le groupe 1 a présenté le meilleur taux de conversion (2,04). Le poids du contenu ainsi que celui du tissu du jabot et du gésier des poulets éviscérés au 21ème jour d'âge au début des phases lumineuses et obscures ont montré une absence de différence significative (P>0,05) entre les traitements. Cependant, en comparant les résultats obtenus pour un même traitement, on a trouvé une différence significative (P <0,05) entre le contenu du jabot au début de la phase lumineuse et celui de la phase obscure du groupe 1 (2 ±1,63 g contre 25,2 ±16,52 g respectivement). D'après ces résultats, le système d'éclairage utilisé dans le groupe 1 a été le meilleur.

***Mots clés**: poulet de chair, système d'éclairage, poids, gain de poids, poids du jabot et gésier, et taux de conversion de nourriture.*

INTRODUCTION

The poultry industry received considerable criticism on welfare grounds regarding the lighting practices it operates, particularly relating to illuminance (low or high light intensity) and light: dark cycles (Prescott and Wathes, 2002). Banks (1979) reported that daylight, the period of light received by birds in each 24 hours, is very important in the broiler's growing stage. It affects the age of maturity, influencing food consumption and body weight. Freeman *et al.* (1981) and Robbins *et al.* (1984) showed that shorter day-length improves bird health and reduces stress but also results in slower growth rate than continuous light. Hooppaw and Goodman (1976) suggested that one of the problems in determining the optimal length of light and darkness time is to determine how long it takes a chick to consume enough feed for rapid growth and how an inactive period is necessary before the bird will actively feed when given the opportunity. Since the length of lighting, not its actual brightness, is the stimulus, a variety of lighting programs, regardless light intensity, have been examined to improve performance, growth, feed conversions, livability and decrease pathophysiological dysfunctions (ascites, sudden death syndrome and leg problems) in broiler chickens.

MATERIALS AND METHODS

1. Animals

Six hundred day-old broiler chicks (Cobb x Cobb) were floor reared on wood shavings, in closed windowless and well-ventilated pens. The chicks were

divided equally and randomly distributed into five light-controlled pens, each one receiving a specific light program. The light patterns given to the chicks were as follow: ***Group1***- 23L: 1D (One light period of twenty three hours per 24 hours) from day 1 to day 7 then followed by 18L: 6D (One light period of 18 hours per 24 hours) from day 8 to day 14 and 13L: 11D (One light period per 24 hours) from day 15 to day 21 and 5L: 3D (Three light periods of 5 hours per 24 hours) from day 22 to slaughter; ***Group 2***- 23L: 1D (One light period of 23 hours per 24 hours) from one day old to day 20 of age, an intermittent light pattern of 5L: 3D (Three light periods of 5 hours per 24 hours) from day 21 to slaughter; ***Group 3-control***- 23L: 1D (One light period of 23 hours per 24 hours) from one day old till slaughter; ***Group 4***- 23L: 1D (One light period of 23 hours per 24 hours) from day 1 to day 7 then followed by 18L: 6D (One light period of 18 hours per 24 hours) from day 8 to day 14 and 13L: 11D (One light period of 13 hours per 24 hours) from day 15 to day 21 and 3L: 5D (Three light periods of 3 hours per 24 hours) from day 22 to slaughter; ***Group 5***- 23L: 1D (One light period of 23 hours per 24 hours) from one day old to day 20 of age, an intermittent light pattern of 3L: 5D (Three light periods of 3 hours per 24 hours) from day 21 to slaughter.

The chicks were vaccinated for Gumboro disease at 10 and 15 days of age and for Infectious Bronchitis and Newcastle at 18 days of age. Heat was provided to the chicks by artificial gas brooders placed at 90 cm above the floor. Birds were brooded at 30°C the first 3 weeks. From the 4^{th} till the 6^{th} week, temperature was reduced to 24°C and then to 21,5°C from week 7 till slaughter. Birds were provided isocoloric rations based on corn-soybean mixture. Food and water were given *ad libitum* through all the experiment. A broiler starter ration (22% CP, 3060 Kcal/Kg ME) usually a crumb was fed to an age of 20 days. Thereafter, a grower pellet (20% CP, 3090 Kcal/Kg ME) was used from day 21 till 30 days of age followed by finisher pellets (19% CP, 3115 Kcal/Kg ME) from day 31 till slaughter.

2. Data collection

Temperature and relative humidity were measured twice a day, in the morning and at noon using dry and wet thermometers. Mortality was recorded daily. Live body weight and feed intake were measured at 20, 30 and 37 days of age. Weight gains and feed conversion ratio were calculated at 20, 30 and 37 days of age.

At the beginning of the grower period (21 days old), five broiler chicks from each group were killed, dissected and eviscerated, where four of them

were killed at the beginning of the light period and the other four at the beginning of the dark period. The crop and gizzard of each sacrificed chick were individually weighed and then reweighed following the complete removal of feed and fluids from these organs. The difference between the two weights was obtained as a measure of feed and fluids mass (grams).

3. Data analysis

For statistical analysis, one-way analysis of variance (ANOVA) was conducted using "Sigmastat software" to evaluate differences between treatment means. Probability levels (P), which are equal to or less than 0,05, were considered significant in all tables, whereas coefficient of determination (r^2) between means was consistent at (*) $P<0,05$, (**) $P<0,01$ and (***) $P<0,001$. Feed conversion ratio (FCR) of broiler chicks obtained in each feeding period was statistically analyzed using chi square (x^2) analysis. Results in tables are illustrated as means (X) ± standard deviation (SD).

RESULTS AND DISCUSSION

1. General health, mortality, and vaccination

Daily observations showed no problems in chicks' health. The broilers had good stature, very few leg weaknesses and showed no symptoms of diseases or food deficiencies. The improvement of broiler's health was the result of extra activity observed in groups receiving intermittent light. Supported by Classen *et al.* (1991), Dale *et al.* (1996) and Renden *et al.* (1996), birds receiving near continuous light were found to be docile during the growth period if compared with those having intermittent light that was more active when the light was on.

Considering mortality, the highest percentage was found in group 3 (7%). Lower percentages were found in groups receiving intermittent light programs; with 1,94% for group 1, 0,97% for groups 2 and 4, and 3,88% for group 5. Gordon and Tucker (1995), Walker (1996) and Van Middlekoop *et al.* (1998) declared that low mortality is a consequence of using intermittent light programs and supported these results.

2. Live body weight

Table 1 shows that different lighting programs did not have any significant effect ($P>0,05$) on live body weight of the broilers at 20, 30 and 37 days of age

in all bird-groups. The lack of significant difference between intermittent light groups was supported by Buckland (1975), Buckland *et al.* (1976) as well as Hooppaw and Goodman (1976) and Zakaria (1985). While Quarles and Kling (1974) and Deaton *et al.* (1980) established an insignificant difference between continuous light and intermittent light groups which agreed with our results.

Relating to control-group 3, all groups presented an increase in body weight at 20 days of age by 0,6% for group 1, 4,7% in group 2, 4,6% in group 4 and 2,3% in group 5. Live body weight of groups 2 and 4 continued to increase insignificantly from day 20 till day 30 of age.

Table 1: Body weights (g) of broiler chicks subjected to different light treatments.

Light treatment	Age (days)		
	20	30	37
1	802,6 ±72	1707,4 ±146,6	2149,6 ±103,3
2	835,4 ±58,3	1737 ±132,2	2106,4 ±108,7
4	835,2 ±80,2	1735,2 ±143,3	2110,2 ±131,8
5	816,2 ±104,9	1697 ±117,8	2022,4 ±210
Control-3	798,1 ±92,4	1712,2 ±141,1	2133,3 ±121,4

At slaughter, only group 1 presented a superior weight when comparing with control-group 3. The tendency for superiority agreed with the findings of Buyse *et al.* (1996), Al Mahrous and Khalifa Mohamed (1997), Rozenboim *et al.* (1999) and Ingram *et al.* (2000). During the same period, group 5 presented the lightest live body weight (-5,2% related to control). The trend for live body weight to be reduced was established by Gordon and Tucker (1997).

3. Weight gain

Table 2 shows that growth of birds per feeding period of the intermittent light groups (group 1, 2, 4 and 5) compared to near continuous light program of birds control-group 3 was higher in all groups by 0,6%, 5%, 4,9% and 2,4%, respectively at the end of the starter period. This increase in weight of groups 1 and 4 receiving decreasing light schedule during this period was not supported by the findings of Moore (1957), Schutze *et al.* (1960) and Beane *et al.* (1965).

In contrast to what was obtained, body weight gain at the end of the grower period was lower in groups 1, 2, 4 and 5 by 1,6%, 5,8%, 5,9% and 5,8% respectively in comparison with control – group 3. Marr *et al.* (1971), who provided evidence of decreased growth response under continuous light, did not confirm these results.

Table 2: Weight gain (%) of broiler chicks subjected to different light treatments.

Light treatment	Age (days)		
	20	**30**	**37**
1	+0,6	-1,6	+31,4
2	+5	-5,8	+8,12
4	+4,9	-5,9	+9,6
5	+2,4	-5,8	-2,5
Control-3	100	100	100

Decrease (-) or increase (+) in body weight gain related to control-group 3 considered as 100%

In contradictory manner, body weight gain increased during the finisher period reaching at the end 31,4%, 8,12%, 9,6%, and 3,7% in groups 1, 2, and 4 respectively while body weight gain in group 5 was still decreasing by 2,5%.

4. Feed intake and food conversion ratio

Table 3 shows that feed consumption per bird per feeding period in the intermittent light treatments compared to near continuous light treatment was slightly lower for the grower and finisher periods.

Data obtained at the end of the starter period showed that consumption of feeds per head was the least in group 1 (1,13 kg) in comparison with groups 3-control (1,22 kg), 2 (1,17 kg), 4 (1,19 kg) and 5 (1,21 kg). According to Ketelaars *et al.* (1986), these results might be the consequence of some adaptation to the change in lighting regimes.

Having lower feed consumption during the grower and finisher period, our results contradicted those of Perry (1981) as well as Ketelaars *et al.* (1986) who suggested that birds under intermittent light are able to adjust their rates of intake in order to have the same amounts as those ingested by the near continuous light.

At the end of the experiment, only group 1 showed an efficient use of feeds by broiler chicks presenting the best FCR (2,04) when compared with control-group 3 (2,23), group 2 (2,46), group 4 (2,37) and group 5 (2,85). Quarles and Kling (1974), Cave (1981), Renden *et al.* (1991) and Ingram *et al.* (2000) supported these results, finding that feed conversion into meat of broilers reared under intermittent light was better than that of broilers reared under continuous light regime. However, FCR obtained in group 5 agreed with the results of Cain (1973), Buckland *et al.* (1973, 1976) and Cherry *et al.* (1980) who showed that poor feed conversion ratio is obtained with intermittent light regime.

Table 3: Feed Intake (FI) and Feed Conversion Ratio (FCR) per bird per feeding period.

Light treatment	Age (days)							
	Starter (20 days)		Grower (30 days)		Finisher (37 days)		Whole period	
	FI	FCR	FI	FCR	FI	FCR	FI	FCR
	(Kg)	(Kg: Kg)	(Kg)	(Kg: Kg)	(Kg)	(Kg: Kg)	(Kg)	(Kg: Kg)
1	1,13	1,5	1	1,11	0,9	2,04	3,03	1,41
2	1,17	1,49	0,99	1,09	0,91	2,46	3,07	1,45
4	1,19	1,51	1,02	1,13	0,89	2,37	3,1	1,46
5	1,21	1,57	1,02	1,15	0,93	2,85	3,16	1,56
Control-3	1,22	1,63	1,05	1,14	0,94	2,23	3,21	1,5

5. Crop and gizzard

Table 4 shows the average weights of feeds and fluids contents of crop and gizzard at the beginning of the grower period. No significant differences among different treatments were observed in average weight of crop contents at the beginning of the light and dark periods ($P>0,05$). Hooppaw and Goodman obtained the same results in 1976, showing no influence of the dark duration on crop contents. The presence of small amounts of feed and fluids in the crop at the beginning of the light period might be explained by what Morris (1968), Cherry and Barwick (1962) and Gordon and Tucker (1997) and obtained previously. They suggested that chicks quickly learn to eat considerable proportion of the total feed intake during darkness when housed on a very short day length and that light was not essential for feeding to occur.

Table 4: Average weight (g) of feed and fluid contents in crops and gizzards of sacrificed broiler chicks at 21 days of age.

			Light treatment				
			1	**2**	**4**	**5**	**Control-3**
Feed & Fluids (g)	**Crop**	**Light period**	2^{a} ±1,63	2,5 ±1,91	9,5 ±6,61	4,5 ± 6,4	4,25 ±3,77
		Dark period	$25,2^{b}$ ±16,52	12,5 ±4,43	28 ±11,43	12,5 ± 3,0	15,75 ±10,82
	Gizzard	**Light period**	11,5 ±5,26	11,5 ±1,91	10,5 ±4,43	14 ±6,32	13 ±6,23
		Dark period	12 ±3,65	13 ±7,39	14,5 ±1	15 ±1,15	13,25 ±2,6
	Combined weight	**Light period**	$13,5^{a}$ ±7,02	14 ±3,65	20^{a} ±10,45	18,5 ±7,54	16,25 ±6,71
		Dark period	37^{b} ±14,28	23 ±7,6	$42,5^{b}$ ±11,12	32,5 ±8,7	30 ±10,14
Tissue mass (g)	**Crop**	**Light period**	4,5 ±1	4,5 ±1	5,5 ±1,91	5 ±1,15	5,25 ±1,83
		Dark period	5 ±1,15	5,5 ±1	5,25 ±2,99	5,5 ±1	4,75 ±1,03
	Gizzard	**Light period**	22 ±2,83	19 ±1,15	21,5 ±3,42	22,5 ±1	20,5 ±2,56
		Dark period	22 ±0	21,5 ±1	22,5 ±1,91	22 ±1,63	22,5 ±3,66

Means with different superscripts between column groups and rows are significantly different (P<0,05)

When comparing crop contents at the beginning of the light period to crop contents at the beginning of the dark period within the same group, significant difference ($P<0,05$) appeared only in treatment 1.

Weight of the gizzard content did not differ significantly between treatments, neither at the beginning of the light period nor at the beginning of the dark period. These results came in agreement to what Hooppaw and Goodman (1976) found in their experiment.

In agreement with Hooppaw and Goodman (1976), insignificant differences were obtained when comparing between groups the combined weight of crop and gizzard contents at the beginning of both light and dark periods. However, the combined weight of group 1 and 4 obtained in the light period differ significantly than the one obtained during the dark period ($P<0,05$).

The net weight of crops and gizzards of broiler chicks, at the beginning of light and dark periods, among all groups has no significant difference ($P>0,05$), where it averages to about 5 g for crops and 21,6 for gizzards. The obtained results agreed with those presented by Hooppaw and Goodman (1976), but with an absence of significant differences between treatments. According to them, chicks must present an adaptation of certain digestive parts in order to consume large amounts of feed in short periods of time, which did not occur in any of the those experiments. However, at the beginning of the light period, a positive relationship appeared in control (group 3), and group 2 between crop tissue mass and feed and fluid contents ($r^2 = 0,5761$) and tissue mass and feed plus fluid content in gizzard ($r^2 = 0,9982$) respectively, as well as, a positive relationship appeared in group 4 between crop tissue mass and contents ($r^2 = 0,9506$).

CONCLUSION

Although an insignificant difference was shown in live body weight of broiler chicks all over the experiment, a tendency to a better performance when applying intermittent light program has been shown according to the results obtained in group 1.

The use of intermittent light programs could be the solution for the problems (high rate of food consumption, low rate of feed conversion under a continuous light program, increase in cost of labor, capital structures and daily expenses mostly in electricity) faced by the Lebanese growers in the business of raising broiler chicks.

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