Journal of Animal and Veterinary Advances 6 (9): 1055-1059, 2007
ISSN: 1680-5593

The Effect of Step down-Step up Lighting Schedule on Broiler Performance

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Abstract: In order to study of step down-step up lighting program on performance and respiratory and circulatory system in broiler, a research was conducted in a completely randomized design, consisting of 2 treatment each in 4 replicates. Total 120 day-old male commercial hybrids of cobb chicks were randomly distributed over 2 rooms, at 14 day of age 1 room with a 23 h light: One hour dark lighting schedule and another room with an step down-step up lighting schedule. The length of the trail was 6 weeks. At 21, 28, 35 and 42 days of age, 1 bird from each pen was randomly selected and weighted before euthanizing. The blood samples were collected for hematocrit assay. The relative weight of the organs (heart, lung, right and left ventricle), abdominal fat percent and characteristics including body weight gain, feed intake, feed convertion ratio were measured at the end of each rearing period. At the end of experiment, 2 birds from each pen were euthanizing for carcass quality. The results of statistical analysis of data obtained indicated that there was no significant effect of lighting program on relative weight of lung and heart, carcass fragment percent and weight gain but there was significant effect on hematocrit percent at 4 and 5 weeks of age, relative weight of right ventricle to both of right and left ventricle ($p<0.01$). Abdominal fat percent of lighting program chicks was lower than of continues lighting broiler ($p<0.05$). In all rearing period lighting program had significant effect on feed intake and feed convertion ratio ($p<0.01$) except in 21 day old. The advantages of slowing down early growth of an Step down -Step up Lighting Schedule are of economic significance in terms of improved feed conversion efficiency and reduced losses due to metabolic disorders such as ascites in broiler chickens.

Key words: Lighting schedule, performance, broiler, effect of step down-step up, SDS

INTRODUCTION

Modern broilers are intensively selected for growth rate in a way that the time which is needed for achieving market weight decreases half of a day every year. This selection in feed efficiency, but on the other hand it increased fat deposition, leg problem and metabolic diseases such as Sudden Death Syndrome (SDS) and ascites (Buyse *et al*., 1998, 1993).

In general, longer dark periods were associated with lower mortality and improved gait scores.

Reduced early growth which increased leg strength was proposed as the rationale of this effect. Broilers reared under longer periods of darkness are reported to experience better health than counterparts under long day light conditions, several physiological explanations can be offered (Sanotra *et al*., 2001; Garner *et al*., 2005).

It is hypothesized that short photo periods early in life will reduce feed intake and limit growth. Recent research comparing 12L:12D, 16L:8D and 20L:4D lighting schedules demonstrated clearly that longer periods of darkness prevent regular access to feed and consequently reduce feed intake and limit growth (Classen, 2004).

Broilers chickens have usullay been kept on a Continuos Lighting (CL) schedule so as to maximize feed intake and growth rate. Studies indicate that the lightning program which has more than 6 h lighting period, improves immunity system (Balog *et al*., 2000; Buyse *et al*., 1998, 1996).

Melatonin is a hormone that is secreted from the pineal gland during darkness (Pang *et al*., 1996). In this way, plasma melatonin concentration reflect environmental lightning conditions (Zeman *et al*., 2001). It regulates daily and seasonal physiological rhythms,

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including the cardiopulmonary, reproductive, excretory, thermoregulatory, behavioral, immunomodulatory and neuroendocrine system (Apeldroorn *et al.*, 1999). So melatonin does various activities in body such as suitable response vaccination, reduction secondary bacterial infections and air sac edema (Cummings *et al.*, 1986). Several studies link melatonin with modulation of metabolism and growth in chicken. Osei *et al.* (1989) have shown that melatonin improves feed conversion ratio but possible mechanisms of action are not understood.

Broiler chickens normally do not eat during darkness as long as this period does not extend for more that about 12h (Apeldroorn *et al.*, 1999) but is step down-step up programs, it is showed that they consume 30-40% feed during darkness (Buyse *et al.*, 1996 , 1998).

However studies showed that alternative lighting schedules, such as increasing or intermittent lighting schedules improve body weight and feed conversion and reduce leg problems and mortality (Buyes *et al.*, 1994 a,b; Apeldoorn *et al.*, 1999) therefore lighting is a powerful exogenous factor in control of many physiological and behavioral processe (Manser, 1996).

Increased environmental complexity in poultry rearing facilities is rcognized as a means to achieve productivity goals and to resolve welfare concerns (Newberry, 1995; Mench, 1998).

Light as an environimental factor consists of three different aspects: intensity, duration and wave length. Light intensity, color and the photoperiodic regime can affect the physical activity of broiler chickens (Olanrewaju *et al.*, 2006).

The objective of the present experiment was to compare the effect of step down-step up lighting program with a continuos lighting schedule (23L:1D) on the performance of broiler chickens.

MATERIALS AND METHODS

Total 200 day old, male broiler chickens (Cobb 500) were obtained from a local hatchery. Chicks were randomly distributed in two light-proof rooms each containing 4 floor pens (25 chicks per pen), the control group rose in nearly continuous lighting [23 h light (L) :1 h dark(D)] and experimental group rose in Cobb company suggested lighting schedule (Table 1).

Feed and water were provided ad libitum throughout the experiment compositions of diets in all phases of the experiment are presented in Table 2 (NRC, 1994). The period of experiment was 6 weeks. Chickens had free access to water and experimental diets. The temperature was kept at 30-32°C in first week and it decreased 2° every week and was stable in 18°C. From day 14 onwards and

Table 1: Lighting schedual

Age (day)	Weight (g)	Lighting period (h)	Darkness (h)	Light intensity (Lux)
1	40	24	0	40
2	48	23	1	40
Until 14	160	18	6	5-10
Until 19	300	15	9	5-10
15-20 (presloughter)	450	12	12	5-10
Presloughter	******	******	******	******
15	-	15	9	5-10
12	-	18	6	5-10
9	-	21	3	5-10
6	-	23	1	5-10
Until slaughter	-	23	1	5-10

Table 2: Composition and nutrient content of experiment rations (%)

Ingredient(%)	Starter	Starter	Finisher
Corn	54.97	60.42	65.1
Soy bean meal	39.5	32.1	27.8
Salt	0.2	0.15	0.15
Di calcium phosphate	1.85	1.66	1.45
Min+vit.premix	0.6	0.6	0.6
Dl-methionine	0.21	0.19	0.17
Lysine	0.07	0.2	0.16
Oister shell	0.95	1.13	1.02
Plant fat	1.6	3.5	3.3
Na2co3	0.05	0.05	0.05
Calculated analysis	****	****	****
ME(kcal/kg)	2885	2950	3000
Crude protein(%)	22.2	19.5	18.06
Lysine(%)	1.26	1.18	1.04
Methionine(%)	0.55	0.5	0.46
Methionine+cyste(%)	0.91	0.82	0.81
Ca(%)	1	0.9	0.8
P%(nonphytate)	0.5	0.45	0.4

repeated weekly, chickens were weighted on a pen basis. Feed intake and feed conversion ratio were measured weekly. Mortality was recorded throughout of the experiment.

From 12 randomly selected birds per group, venous blood samples were taken weekly from day 21 onwards. Each week blood samples were collected in heparinized capillary tubes for determination of Packed Cell Volume (PCV) (at weeks 3,4,5 and 6).

The heart of these birds were removed and the atria, major vessels and fat were trimmed off. The Right Ventricle (RV) was dissected away from the left ventricle and septum. The right and left ventricular weights were determined separately and the right and left ventricles and septum were added and the Total Ventricular weight (TV) determined. Birds having a RV/TV of over 0.299 were classified as suffering from right ventricular failure (Julian,1987). The relative weight of organs (heart, lung) and abdominal fat percentage were measured. At the end of experiment, 2 birds from each pen were euthanizing for carcass fragment percent (thigh, breast, wing, neck and back). From 1-14 day of age, the lighting schedule was according to the experimental protocol and the chickens were already exposed to the experimental treatments.

Statistical analysis: The experiment was a completely randomized design with two treatments each applied to the same number of units. The data were subjected to statistical analysis based on 4 replications per treatment. The data was analysed using the SAS program (SAS institute, 1986). The means of variables were compared using Duncan's multiple range test (Duncan, 1995).

RESULTS AND DISCUSSION

Growth performance: Weight gain, feed intake and Feed Conversion Ratio (FCR) for the different treatments and results of statistical analyses are summarized in Table 3.

Imposing the step down-step up program at 4 weeks of age significantly reduced the feed intake and feed conversion ratio ($p<0.01$). At the experimental period there was no significant difference in weight of birds under the different lighting programs.

The casual endocrine mechanisms responsible for compensatory growth and the concomitant improvement on the production efficiency of poultry are not completely understood (Buyse *et al*., 1998; Lippens *et al*., 2002). In some experiments feed intake of Intermittent Lighting (IL) chickens were higher than of Continuous Lighting (CL) group in 3-6 weeks of age (Ohtani and Leeson, 2000). Additionally, Buyse *et al*. (1994a,b) observed that, when growth was retarded in young birds, heat production and, hence, oxygen requirements per kilogram metabolic body weight of the chickens under IL were considerably lower than those of birds reared under CL. This resulted from a lower total heat increment, as feed intake was considerably lower and also from lower activity-related heat production. An nitial reduction of weight gain, which is induced by a temporary reduction in energy intake at a young age, reduced metabolic rate and lowered oxygen requirements of birds and, consequently, their suspectibility to ascites (Buyse *et al*., 1998).

In another study observed that IL chickens used at feeder and vigorously ate at one time just after the starting of lighting period, whereas CL chickens showed little excitement at eating. They also concluded that, in lighting program chickens, the upper digestive tract might have been empty during the period of darkness and the birds were immediately again ready to eat when light come on. The lower feed conversion in the present study with lighting program was related to reduced feed intake and not to altered growth rate. However, Simmons (1982) and Buyse *et al*. (1994a) found lower feed conversion together with a higher growth rate under Intermittent Lighting (IL). The difference in metabolizability, in general, could be due to a difference in digestion or a difference in energy losses with urine. It is, however, unclear how lighting scheduale might affect digestibility. One explanation could be due to greater waste of feed under the continuous lighting scheduale (Apeldroorn *et al*., 1999). Forbs and Injidi (1979) reported that exogenous melatonin depressed feed intake of chickens that have been exposed to darkness. Melatonin levels are high during the scotophase (darkness) and low during photophase (light period). Despite the lower feed intake in broilers exposed to long houres of darkness, their body weight gains comparable with those of broilers exposed to the CL.

Effect of lighting program on feed conversion ratio has been reported in many experiments (Buyse *et al*.,

Table 3: Feed intake, body weight gain, feed conversion efficinency

	Week 3			Week 4			Week 5			Week 6		
	Ferd intake (gr)	Weight gain (gr)	Feed convertion rate	Ferd intake (gr)	Weight gain (gr)	Feed convertion rate	Ferd intake (gr)	Weight gain (gr)	Feed convertion rate	Ferd intake (gr)	Weight gain (gr)	Feed convertion rate
Control	407.49[a]	316.9[a]	1.29[a]	624.56[a]	447.3[a]	1.40[a]	812.92[a]	530.45[a]	1.53[a]	1238.33[a]	664[a]	1.86[a]
Lighting schedual	378.61[a]	306.3[a]	1028[a]	598.27[b]	447.3[a]	1.33[b]	784.07[b]	529.8[a]	1.48[b]	1141.3[b]	662[a]	1.72[b]
SEM	7.2	3.62	0.1	2.68	1.54	0.005	3.8	1.52	0.006	3.56	1.031	0.007

a,b Mean values in the same column with different superscript letters were significantly different ($p<0.01$)

Table 4: Carcass fragment weight

	Tigh	Breast	Wing	Neck	Back
Control	32.56	29.92	11.59	7.84	19.22
Lighting schedule	33.10	30.22	11.61	30.22	33.10
SEM	0.68	0.27	0.24	0.11	0.099

Table 5: Relative weight of internal organs to the body weight

	Week 3				Week 4				Week 5				Week 6			
	Lung	Heart	Abdominal fat	RV/TV	Lung	Heart	Abdominal fat	RV/TV	Lung	Heart	Abdominal fat	RV/TV	Lung	Heart	Abdominal fat	RV/TV
Control	0.60	0.0059	1.26[b]	20.24	0.52	0.0052	1.78[b]	19.34	0.51	0.0044	1.82[b]	19.56	0.59	0.0042	2.25[b]	19.58
Lighting schedual	0.62	0.0059	1.15[a]	20.27	0.53	0.0055	1.67[a]	19.37	0.52	0.0044	1.76[a]	19.76	0.59	0.0042	2.09[a]	19.31
SEM	0.008	0.00005	0.075	0.0028	0.005	0.00005	0.032	0.0001	0.014	0.00005	0.033	0.0016	0.005	0.00005	0.33	0.0018

a,b Mean values in the same column with different superscript letters were significantly different ($p<0.05$)

1993, 1994b, 1996; Classen, 2004). Mortality in each treatment was similar to standard rate and there was no significant difference between treatment for this trait, this result is in agreement with findings of other researches (Buyse *et al*., 1994).

Carcass fragment: Data for relative weight of carcass fragment (thight, breast, wing, neck and back) are presented in Table 4. There weren't any significant differences in the carcass fragment weight. A reduction (0.2%) in breast yield under an increasing photoperiod program was confirmed by Newcombe *et al*. (1992). Haye *et al*. (1978) reported that the wing weight increased in birds under lighting program, because they believe that when the lights turned on birds started to jumping motions of course the reason of these movements are unknown but they suggested broiler chickens raised in lighting program had higher plasma corticosteron hormone level than birds under a CL regimen. Corticosteron prepare birds for stress conditions.

Relative weight of internal organs

Percentage of abdominal fat: The percentage of abdominal fat of lighting program chicks was lower than of continues lighting broiler ($p<0.05$). These results are shown in Table 5. Use of lighting program significantly reduced abdominal fat weight. This finding in agreement with the results of Buyse *et al*. (1996). Abdominal fat, a factor that downgrades carcass was significantly reduced by lighting program, suggesting that this could be a tool in reducing abdominal fat hence enhancing carcass quality (Oyedeji and Atteh, 2005). Newcombe *et al*. (1992) demonstrated that yield of abdominal fat was increased when birds were exposed to photoperiod increases from 6-23 h conversely.

Lung to the body weight ratio: The results of the comparison between the effect of lighting program on relative weight of lung are shown in Table 5. The lighting program had no significant effect on lungs weight.

Heart to the body weight ratio: The results of the statistical analyses are summarized in the Table 5. There was no significant effect on heart weight.

RV/TV ratio: Right Ventricle (RV) to Total Ventricle (TV) weight (RV/TV) in the different groups are presented in the Table 5. The lighting program had no significant effect cardiac measurements or RV/TV of these birds.

Pucked Cell Volume (PCV) percent: The results of comparison between PCV in different experimental weeks are shown in Table 6. Lighting program had no significant effect on the PCV expect at 4 and 5 weeks of age($p<0.01$).

Table 6: Pucked cell volume (PCV) percent

	Week 3	Week 4	Week 5	Week 6
Control	32.39	29.11^{b}	33.31^{b}	27.74
Lighting schedule	32.08	28.57^{a}	32.66^{a}	27.31
SEM	0.002	0.002	0.002	0.002

a,b Mean values in the same column with different superscript letters were significantly different ($p<0.01$)

Generaly lighting program decreases activity and basal metabolism and adjutes the growth rate of internal organs and these reduces metabolic disorders rate (Buyse *et al*., 1996; Haye *et al*., 1978).

The results of RV/TV ratio are in agreement with findings of other researchers (Hassanzadeh *et al*., 2000). Lighting program can improve the oxygen consumption and decreased PCV (Buyse *et al*., 1998). The lower PCV induced by intermittent lighting may decrease blood viscosity in the narrow capillaries of the lungs as a consequence, could reduce pulmonary hypertension and ascites (Julian, 1993). Hassanzadeh *et al.* (2000) found that the reduction in mortality due to ascites also coincided with lower plasma T_3 concentration and PCV in birds under lighting program, suggesting that the lower metabolic rate had a beneficial effect on the incidence of ascites. The significant effect of T_3 on the right ventricular weight and the total ventricular weight and the absence of an effect of T_3 on the left ventricular weight. Indicates the involvement of right ventricular hypertrophy in the functional hyperthyroidism model of ascites in broiler chickens (Decuypere *et al*., 1994; Charles *et al*., 1992).

From the practical point of view, Lighting program may be used as an efficient management technique for broiler production during hot season in tropical and subtropical area. Furthermore, the present study showed that lighting schedule also influenced feed conversion, improvement in feed conversion with step down-step up lighting schedule compared to continuous lighting schedule was to a ME/GE and a lower energy expenditure for physical activity.

ACKNOWLEDGMENT

The authors are grateful to Azar Toyokh company for excellent financially helping.

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