*3rd Scientific Congr. of Egypt. Soc. For Anim. Manag. 28-29 Oct.,2008 :5- 19*

# INFLUENCE OF LIGHT-DARK SCHEDULES ON BROILER BEHAVIOUR, FEARFULNESS AND PERFORMANCE

**BY**

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## SUMMARY

The aim of this study was to investigate the effect of light-dark schedule on the behaviour of broiler chickens, fearful as well as performance. 300 broilers (Cobb 500) were reared on the floor and exposed to three different lighting programs (continuous, intermittent, restricted lighting). Broilers' behaviours were classified into eight activities that were standing, sitting, feeding, standing feeding, lying feeding, drinking, foraging, and preening. These activities were recorded at 2, 4 and 6 weeks of age. The duration of tonic immobility (TI) and the number of induce TI were recorded as indicator of fearfulness. High proportion of broilers that kept under restricted lighting program showed more time feeding while standing ($P$=0.01), foraging ($P$=0.05) and preening ($P$=0.05) when compared with broilers under other programs. Contrary, broilers were reared under intermittent lighting spent more time sitting and less time feeding. Chicks were exposed to continuous and restricted lighting were lighter in body weight (1993.10, 1807.89 g, receptivity) than those were exposed to intermittent lighting program (2079.94 g, $P$=0.01). Broilers housed under restricted lighting showed significantly longer duration of tonic immobility than other lighting programs ($P$=0.05). These results confirmed that a

reduced growth rate improved the bird mobility and such behaviour is a indicator to leg problems.

## INTRODUCTION

Lighting is a powerful exogenous factor in control of many physiological and behavioural processes. Light may be the most critical of all environmental factors to birds. In addition, light allows the bird to establish rhythmicity and synchronize many essential functions, including body temperature and various metabolic steps that facilitate feeding and digestion. Of equal importance, light stimulates secretion of some hormones that control, in large part, growth, maturation, and reproduction.

Lighting duration, i.e., photoperiod, is the major aspect of light that will change broiler performance. Most research involving light management has focused on this factor. Different photoperiodic regimes have been applied and tested over the years, while almost all of them have been shown to improve broiler welfare with conventional near-continuous lighting **(Gordon, 1994).** In the same time, darkness is as important to growth and health of broilers as light (**Classen *et al*., 1991).** Broiler light-dark schedules can be characterized in a number of ways, including hours of darkness and how many periods of darkness are included in each 24 hours cycle. When photoperiod is maintained at a constant level throughout the growth cycle of broiler chickens, shorter day length is associated with slower growth **(Li *et al.*, 1995).** Continuous light disrupts the diurnal rhythm and has some welfare concerns. Among those are high prevalence of leg and skeletal disorders in poultry **(Sanotra *et al*., 2001, 2002)** and affected birds may even experience difficulty in getting to feed and water **(Wong-Valle *et al.*, 1993).**

In addition, birds that are able to maintain an uninterrupted diurnal rhythm are normally able to organize patterns of behaviour, such as eating, sleeping, resting and locomotion according to night and day. Moreover, broilers that exposed to intermittent lighting are more active during the light periods **(Simmons, 1982; Simmons and Haye, 1985)**. Furthermore, introduction of a moderate day length of 16 h is associated with potential welfare benefits **(Gordon, 1994; Davis *et al*., 1997; Rozenboim *et al.*, 1999**), including lower physiological stress, improved immune response, increased sleep, increased overall activity, and improvement in bone metabolism and leg health **(Classen *et al*., 2004)**.

Genetic selection has resulted in high yield broilers that can attain market weight in reduced time based on fast growth rates and improved feed conversion (**Sulistiyanto *et al.*, 1999; Havenstein *et al.*, 2003)**. However, rapid and accelerated growth has resulted in several health and welfare concerns. Of particular concern are diseases and anomalies of the skeletal and circulatory systems. It is not uncommon for more than 2% of broilers to be condemned or down-graded during processing as a result of leg abnormalities **(Morris, 1993)**.

Fear reactions protect animals against predators and are of primary importance for an animal's survival. Tonic immobility is an adaptive psycho-physiological response characterized by reduced reaction induced by physical restraint and has been widely used as a measure of fearfulness in poultry **(Gallup, 1979; Jones and Faure, 1981)**. Indeed, information on the effect of lighting schedule on fear reaction is generally little. Exposure of chickens to continuous lighting (23L: 1D) showed longer tonic immobility duration compared with broilers housed under 2 changing light-dark schedules **(Sanotra *et al.*, 2002)** or hens kept under 14L: 10D

**(Campo and Davila, 2002).** On the contrary, **Stub and Vestergaard (2001)** found that no significant effect of lighting program on fear reaction. The purpose of the present study was to analyze the effect of three lighting programs on the behaviour of broiler chickens, number of induction of tonic immobility, the duration of tonic immobility reactions as well as body weight.

## MATERIALS AND MEHTODS

The experiment protocol was performed in the animal house at faculty of veterinary medicine, Sadat branch, Menoufia University during the period from August to October.

### Birds management

300 one day old male and female Cobb 500 broilers were obtained from Misr Arabia company for poultry (Sadat city). They were reared on the floor and exposed to three different lighting programs. Chicks were randomly allocated to 3 the experimental rooms, consisting of 2 pens (1.7 x 2.7 m) per room (2 replicates), which housed 50 birds per pen at stocking density 10 birds / $m^2$. Each pen was provided with wood shaving litter. The broilers had access to feed and water ad libitum. Initially, room temperature was maintained at 33 – 35° C and were reduced gradually by about 2.8 – 3° C per week until 20 – 22° C was reached in the sixth week of age.

#### Light-dark schedules

Lighting intensity in all treatments were 20 – 35 lux for the first four days of age then reduced to 5 – 10 lux for the rest of the experiment. Light-dark programs were designed as shown in Table (1).

**Table 1**. Summary of light-dark schedules:

| **Programs** | **Age (day)** | **Light: dark** |
|---|---|---|
| Continuous lighting (CL) | 0 – 4 | 24L: 0D |
| (Morris, 1967) | 5 – 42 | 23L: 1D |
| Intermittent lighting (IL) | 0 – 4 | 24L: 0D |
| (Rahimi *et al.*, 2005) | 5 – 42 | 1L: 3D |
| Restricted lighting (RL) | 0 – 4 | 24L: 0D |
| (Charles, 2003) | 5 – 8 | 18L: 6D |
| | 9 – 14 | 14L: 10D |
| | 15 – 21 | 16L: 8D |
| | 22 – 28 | 18L: 6D |
| | 29 – 42 | 22L: 2D |

## Measurements

### I- Behavioural observations

The undisturbed behaviour of the broiler chicks in the rearing room was recorded for 10 minutes at the second, fourth and sixth weeks of age via video camera (Panasonic, Japan). Every 5 minutes starting from the period of recording, the tape was stopped by using the pause button, and the behaviours of all birds in the frame were noted **(Martrenchar et al. 1999)**. Behaviour was classified into eight mutually exclusive activities that were defined as follows. Standing: the bird is standing motionless and does not perform any other elements. Sitting:, resting the abdomen on the litter but holding head raised. Feeding: beak in or above the feeder, or feeder directed either in standing or sitting positions. Standing feeding: beak in or above the feeder during standing position. Lying feeding: beak in or above the feeder during sitting position. Drinking: beak in or above the drinker, or

drinker directed. Foraging: the bird is pecking or scratching in the litter or is standing / moving with its head in a lower position than the rump. Preening:, beak touching the plumage of the bird itself.

## II- Tonic immobility test

At 39 days of age, the tonic immobility (TI) reactions of 10 broilers of each group were measured. As soon as the birds were carried, TI was induced by gently restraining them on its back for 15 s in a V-shaped metal cradle covered with several layers of clothing, with the head hanging outside as described by Jones and Faure (1981). The experimenter then retreated approximately 1.5 m and remained within the sight of the bird but made no unnecessary noise or movement.. A stop watch was started to record latencies until the bird righted itself. The bird was considered as being in a state of TI if it remained immobile for a minimum of 10 s after removing the operator's hand. The maximum duration of TI was set to 300 s. If the bird righted itself in less than 10 s, the procedure was repeated again. If TI was not induced after three attempts, the bird was given a zero score. The number of inductions and the duration of TI, latency to self-righting, was recorded for each bird..

## III- Live body weight

The live body weight for each group were recorded at 2, 4 and 6 weeks of age.

## Statistical analysis

Statistical analyses were performed by using the SAS system **(SAS Institute Inc., 1999).** The data obtained from behavioural activities, TI, and body weight were subjected to analysis of variance technique (ANOVA using PROC GLM).

## RESULTS AND DISCUSSION

There were a number of interesting findings from this study. Shorter photoperiod (intermittent lighting, 6L:18D totally per day) was associated with significantly higher body weight at the fourth and sixth week of age (Figure 2). This result is disagree with **Sørensen et al. (1999)** who reported that increased photoperiod was associated with increases in body weight. It may be possible that birds that were exposed to short periods of lighting are not satisfy and need to compensate this defect by feeding during the dark period **(Morris, 1968).**

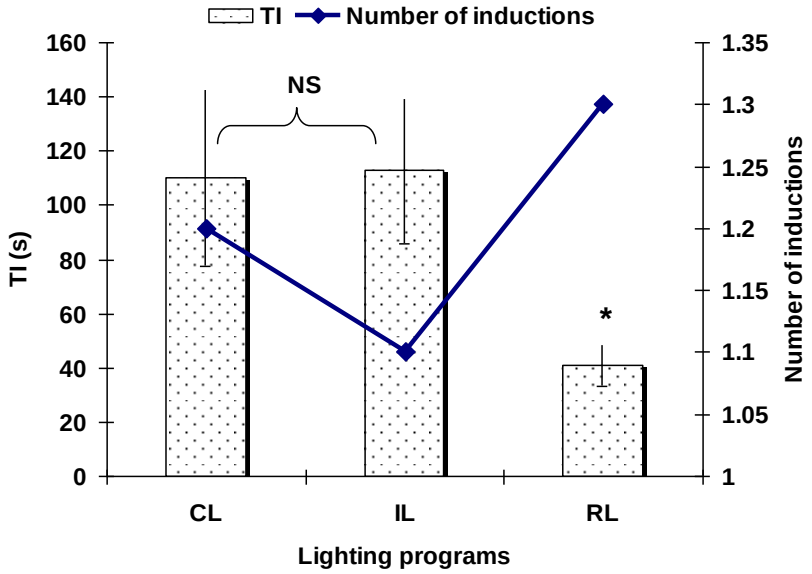


**Figure 1.** *Effect of light-dark schedules (continuous, CL, intermittent, IL and restricted lighting, RL) on tonic immobility (TI) and number of induction required to induce of TI at 39 days old ( * P<0.05)*

Moreover, observations of feeding behaviour did confirm this where birds kept under intermittent lighting were significantly showed lower feeding activities than

other groups were exposing to long lighting period (Table 2). If given a choice, chickens prefer to eat during the photoperiod, although they will eat during darkness if insufficient periods of light are provided **(Simmons, 1982).**

Behavioural activities (standing feeding, foraging and preening) among broilers subjected to restricted lighting were increased when compared to other lighting programs as shown in Table 2. Our results are in agreement with the findings of **Simmons (1982) and Blokhuis (1990**) who found high levels of locomotion, preening and eating in chicks reared using light-dark schedules as compared with broilers reared under continuous lighting. Broilers that were exposed to continuous lighting showed little mobility that appears in the form of less foraging behaviour (Table 2). It is probable that broilers reared in continuous light are unable to maintain a diurnal rhythm and reduced ability for orientation **(Coenen *et al.*, 1988; Blokhuis, 1983).** In the same time, broilers kept under restricted lighting were lighter in body weight than groups reared in continuous or intermittent lighting. This light body weight may lead to low leg problems and make the birds less stress thus less fearful (as shown in Figure 1). **Gordon (1994)** commented that increased activity in birds reared under moderate photoperiod contributed to a reduction in leg weakness. However, some studies reported reductions in live weight gain in birds kept under moderate photoperiods **(Classen and Riddell, 1989)**. Consequently, it is important to evaluate whether the reduction in live body weight or are independent of it. On the contrary, broilers housed under intermittent lighting were observed sitting most of the time and spent less feeding time while standing (Table 2, 3). This may be attributed to their heavy body weight that impaired mobility as a result leg weakness (Figure 2).

There were significant differences between lighting programs for the tonic immobility duration (Figure 1). Tonic immobility of broilers housed under continuous and intermittent lighting (110.10 ± 24.72, 116.70 ± 24.73 s, mean ± SE, respectively) was longer than that of broilers housed under restricted lighting (41.10 ± 24.72 s, *P*=0.05). This may be suggested that nearly continuous **(Campo and Davila, 2002)** and intermittent lighting caused greater fearfulness. The number of induction required to achieve the tonic immobility reaction was similar between groups (CL: 1.20 ± 0.13, IL: 1.10 ± 0.13, RL: 1.30 ± 0.13, mean ± SE, *P*=0.563).

Table 2. Effect of light-dark schedules (continuous, CL, intermittent, IL and restricted lighting, RL) on the percentages of broilers engaged in different activities in scan samples (LSMeans ± SE):

| **Behavioural activities** | **Light-dark schedules** | | | ***P* value** |
|---|---|---|---|---|
| | **CL** | **IL** | **RL** | |
| Standing | 12.11 ± 1.41 | 12.61 ± 1.45 | 13.53 ± 1.48 | NS |
| Sitting | 46.07 ± 2.49$^{ab}$ | 52.12 ± 2.49$^{a}$ | 44.45 ± 2.59$^{b}$ | * |
| Feeding | 32.77 ± 1.73$^{a}$ | 24.84 ± 1.73$^{b}$ | 31.28 ± 1.91$^{a}$ | ** |
| Standing feeding | 25.73 ± 1.56$^{ab}$ | 22.87 ± 1.63$^{b}$ | 28.70 ± 1.73$^{a}$ | * |
| Lying feeding | 9.05 ± 1.33 | 7.64 ± 2.07 | 11.03 ± 4.25 | NS |
| Drinking | 11.12 ± 1.51 | 11.02 ± 1.39 | 11.93 ± 1.52 | NS |
| Foraging | 5.11 ± 0.52$^{b}$ | 7.20 ± 1.46$^{ab}$ | 12.50 ± 2.32$^{a}$ | * |
| Preening | 6.95 ± 1.08$^{b}$ | 7.70 ± 0.77$^{b}$ | 12.01 ± 0.74$^{a}$ | *** |

*** *P*=0.001, ** *P*=0.01, * *P*=0.05, NS: non significant

**Table 3.** Effect of light-dark schedules (continuous, CL, intermittent, IL and restricted lighting, RL) on the percentages of broilers engaged in different activities in scan samples (LSMeans ± SE) at second, fourth and sixth weeks of age:

| Behavioural activities | Age (week) | Light-dark schedules | | | *P* values |
|---|---|---|---|---|---|
| | | CL | IL | RL | Interaction† |
| Standing | 2 | 16.88 ± 2.40$^{a}$ | 16.85 ± 2.28$^{a}$ | 21.29 ± 2.27$^{a}$ | NS |
| | 4 | 5.63 ± 2.55$^{b}$ | 9.88 ± 2.28$^{b}$ | 6.79 ± 2.40$^{bc}$ | |
| | 6 | 13.83 ± 2.40$^{a}$ | 11.11 ± 2.94$^{ab}$ | 12.50 ± 2.94$^{b}$ | |
| | *P* values | * | ** | ** | |
| Sitting | 2 | 29.95 ± 4.31$^{b}$ | 41.87 ± 4.30$^{b}$ | 16.75 ± 4.82$^{b}$ | ** |
| | 4 | 68.46 ± 4.32$^{a}$ | 57.01 ± 4.31$^{a}$ | 58.64 ± 4.32$^{a}$ | |
| | 6 | 39.80 ± 4.30$^{b}$ | 57.50 ± 4.31$^{a}$ | 57.96 ± 4.31$^{a}$ | |
| | | *** | ** | *** | |
| Feeding | 2 | 41.58 ± 2.99$^{a}$ | 24.75 ± 2.98 | 34.90 ± 3.00$^{a}$ | ** |
| | 4 | 17.97 ± 3.00$^{b}$ | 25.59 ± 2.99 | 22.22 ± 2.99$^{b}$ | |
| | 6 | 38.75 ± 2.99$^{a}$ | 24.17 ± 3.00 | 36.74 ± 3.87$^{a}$ | |
| | | *** | NS | ** | |
| Standing feeding | 2 | 32.27 ± 2.72$^{a}$ | 17.52 ± 2.71$^{b}$ | 34.90 ± 2.72$^{a}$ | ** |
| | 4 | 16.89 ± 2.70$^{b}$ | 25.04 ± 2.71$^{a}$ | 21.53 ± 2.71$^{b}$ | |
| | 6 | 28.04 ± 2.71$^{a}$ | 26.04 ± 3.03$^{a}$ | 29.67 ± 3.50$^{ab}$ | |
| | | ** | * | ** | |
| Lying feeding | 2 | 11.63 ± 1.87$^{a}$ | 9.03 ± 1.87 | 10.50 ± 2.72 | NS |
| | 4 | 3.62 ± 3.05$^{b}$ | 5.56 ± 5.29 | 6.90 ± 5.28 | |
| | 6 | 11.90 ± 1.76$^{a}$ | 8.33 ± 2.64 | 14.14 ± 3.05 | |
| | | * | NS | NS | |
| Drinking | 2 | 9.22 ± 2.84$^{ab}$ | 11.33 ± 2.14$^{ab}$ | 9.58 ± 1.89 | NS |
| | 4 | 7.57 ± 2.14$^{b}$ | 6.73 ± 2.54$^{b}$ | 9.56 ± 2.54 | |
| | 6 | 16.56 ± 2.84$^{a}$ | 14.99 ± 2.53$^{a}$ | 16.67 ± 3.27 | |
| | | ** | * | NS | |
| Preening | 2 | 7.73 ± 1.08$^{a}$ | 6.61 ± 1.27 | 9.02 ± 1.16$^{b}$ | *** |
| | 4 | 4.78 ± 1.07$^{b}$ | 8.15 ± 1.42 | 7.56 ± 0.95$^{b}$ | |
| | 6 | 8.33 ± 2.85$^{ab}$ | 8.33 ± 1.27 | 19.45 ± 1.64$^{a}$ | |
| | | * | NS | *** | |

†Interaction between age and lighting programs. a-c litters of the different significant within the columns. *** *P*=0.001, ** *P*=0.01, * *P*=0.05, NS: non significant

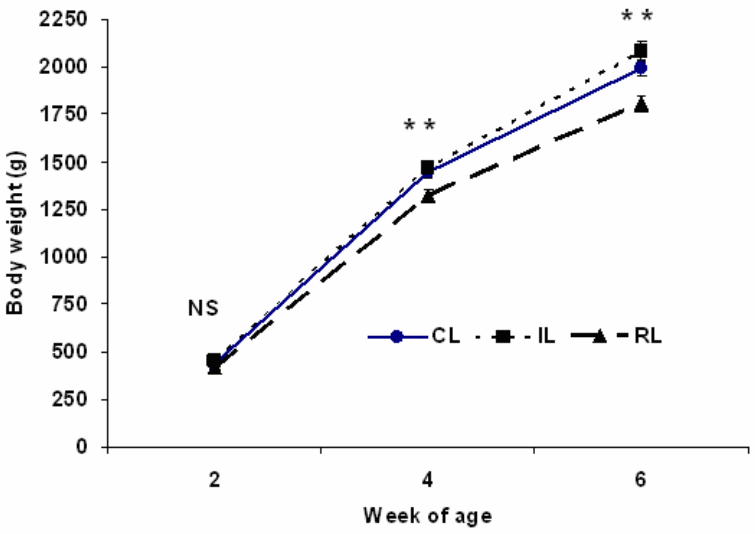


Figure 2. Effect of light-dark schedules (continuous, CL, intermittent, IL and restricted lighting, RL) on body weight (g) at second, fourth and sixth weeks of age (** P<0.01)

Conclusion: this study tends to indicate that moderate photoperiods, applied to broilers during the first 3 week of age, are less stress, improve performance and have beneficial effect on the welfare. Also, introduction of darks periods increases the general level of activity during the day and reduces fear.

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# تأثير برامج الإضاءة و الظلام علي سلوكيات و خوف و أداء بداري التسمين

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استهدف هذه البحث دراسة تأثير ثلاث برامج للإضاءة و الظلام المختلفة (إضاءة مستمرة – إضاءة متقطعة – إضاءة محددة) على سلوكيات و خوف و أداء كتاكيت التسمين.

استخدم في هذه التجربة سلالة Cobb 500 من عمر يوم. وقسمت الى ثلاث مجموعات. المجموعة الأولى تعرضت للإضاءة المستمرة 24 ساعة ضوء : ساعة ظلام. و المجموعة الثانية تعرضت للإضاءة المتقطعة ساعة ضوء : 3 ساعات ظلام. و المجموعة الثالثة تعرضت للإضاءة المحددة 18 ساعة ضوء : 6 ساعات ظلام خلال الأسبوع الأول بداية من اليوم الخامس ثم 14 ساعة ضوء : 10 ساعات ظلام خلال الأسبوع الثاني ثم 16 ساعة ضوء : 8 ساعات ظلام خلال الأسبوع الثالث ثم 18 ساعة ضوء : 6 ساعات ظلام خلال الأسبوع الرابع ثم 22 ساعة ضوء : 2 ساعة ظلام حتى نهاية التجربة. تم تسجيل السلوكيات المختلفة الطيور تحت كل معاملة عند الأسبوع الثاني و الرابع و السادس و كذلك تم اختبار مدة الثبات المتوتر للطائر (Tonic Immobility) كمؤشرات للمعاناة و الخوف و كذلك وزن الطيور.

وكانت النتائج كالتالي: تأثرت سلوكيات الطيور بالمعاملات المختلفة للإضاءة. حيث زاد نشاط الطيور المتعرضة للإضاءة المحددة وذلك ربما لأنها الأقل في وزن الجسم بالمقارنة بالمجموعات الأخرى. كما أنها كانت أقل خوفا من الطيور التي تعرضت للإضاءة المستمرة و المتقطعة. من هذه النتائج تتضح أن الإضاءة المحددة مناسبة لبداري التسمين حيث تزيد من نشاط الطائر بالتالي نقلل من مشاكل الإصابة بضعف الأرجل.