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Effect of the Colour of Light on Growth Performance, Behaviour and Bone Parameters of Broiler Chicken

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ABSTRACT. *This study examined the effect of the colour of light on growth performance, feed and water intake, behaviour and latency to lie (LTL) in broiler chickens. Ninety six broiler (Hybro P.G. Plus) chicks were divided into two groups and reared in 12 cages that received either red or white colour light (20 lux) during night for 8 hrs per day from 14-36 d of age. Water and feed were provided ad libitum. Behaviour was recorded on the broad mutually exclusive categories, walking, standing, litter eating, drinking, eating, aggression, feather pecking, bird interaction, lying and dust bathing by adopting scan sampling method. Birds were weighed weekly. Daily feed intake and water intake were measured during day time and during the artificial lighting period. Though light colour did not affect the final body weight (BW), birds reared under red colour light tended (P=0.08) to have higher weight gain (1366 g) compared to those grown under white light (1305 g). Feed and water consumption patterns, feed conversion ratio (FCR) were not significantly affected by the colour of lighting. Irrespective of the light colour, the average feed and water intake of the birds were (P<0.05) higher during day time compared to those at night time. Broilers who received red colour lighting during night time had high LTL during day time. However, the overall LTL results showed that birds exposed to white light had significantly (P<0.005) higher LTL (3.13 min.) than those exposed to red light in the night (1.61 min.). Bone parameters were not affected by the colour of light. When the behavioural parameters were considered, drinking during night time was high under red light condition. A high tendency of lying down during day time was observed when birds were exposed to white light during night. Feather pecking and dust bathing behaviours during day time were high (P<0.05) among the birds that were exposed to red light during night. These results suggest that rearing broiler chicken in red or white colour lights at 20 lux intensity during night time in a hot, humid tropical environment has no effect on growth, performance but affects behaviour and LTL.*

INTRODUCTION

Eyes are the main sense organs, and vision is one of the main senses that influence broilers. Light environments that restrict the efficacy of visual possessing may reduce welfare if important visual information is lost or corrupted by the environment. For example, birds

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may be unable to recognize important features of other birds, navigate their way around the featureless landscape of a poultry house, recognize and respond appropriately to humans, or see their feed and water clearly if vision is lost (Prescott *et al.,* 2003).

There are several features of the physical light environment in a broiler pen that may affect the birds' welfare. One of the most important features of the physical light environment of a broiler house that may affect the birds' welfare is the colour of the light. Colour, which is detected by wavelength, exerts variable effects on broiler performance. None of the commonly used types of fluorescent light emits appreciable amounts of ultraviolet A light (UVA, 320-400 nm). Daylight has a relatively even distribution of wavelengths between 400 and 700 nm (Olanrewaju *et al*., 2006). One of the most serious welfare problems in broiler production associated with the rapid growth is the high incidence of skeletal disorders, particularly those that lead to impaired mobility or lameness (European Commission, 2000). Light environment can also affect lameness and mortality through many potential routes; directly through light intensity, colour and photoperiodic regime and indirectly via properties of litter quality (Bizeray *et al.,* 2002).

The majority of broiler operations in Sri Lanka are conducted in intensively managed buildings where artificial light is provided. The perception of this light by poultry is not known, although there is a scope for colour signals to be lost or corrupted under artificial lighting. Effects of light colour on growth and welfare have been studied by several authors (Prayitno e*t al.,* 1996, 1997, Prescott *et al.,* 2003; Classen 2004; and Olanrewaju *et al*., 2006;). However, studies conducted under hot humid tropical conditions on these aspects, are limited. Therefore, the objective of this study was to investigate the effects of two colours of light upon production, behaviour and leg bone parameters of broilers under hot humid environmental and local management conditions.

MATERIALS AND METHODS

Birds and general management practices

Ninety six broiler chicks of commercial meat strain (Hybro P.G. Plus) obtained from a local commercial hatchery were reared for the first two weeks under normal brooding light before being allocated to two groups balanced by weight. Each group was given a colour treatments, either red or white (control), from 14 to 38 days of age. Birds of each treatment were housed in 6 cages (18 ft^2), each containing 8 birds. Cages were separated by wire mesh and the side walls were covered with thick black polythene. All the cages were identical apart from the light environment. Paddy husk was used as litter material. Birds were fed with commercial broiler starter diet from day 1 to 14 and finisher pellet ration thereafter up to the end of the experiment, and had free access to feed and water.

Light environment

The irradiance of each light source, red and white, was measured at bird eye level to provide moderate light intensity (20 lux) recommended by the Farm Animal Welfare Council of United Kingdom (FAWC, 1992). Same intensity of light was facilitated by covering and adjusting the height of the light source. A photoperiod of 20 hrs was provided with 4 hrs

darkness beginning at 1800 hrs. Artificial lighting was provided for nine hours from 2200 hrs to 0700 hrs of the following day.

Measurements

Birds were weighed weekly. Feed consumption and water intake were measured during the day time (0700-2200 hrs) and during artificial lighting period (2200-0700 hrs). Maximum and minimum temperatures were recorded in each cage daily.

"Latency to lie" (LTL) test as described by Weeks *et al.* (2002) was used as an indirect measure of the bone strength. Two birds from each experimental cage were randomly taken for LTL test at 34 days of age. These birds were placed in a water proof test pen which was flooded with a shallow layer (30 mm) of water. As chickens do not prefer to sit in water, flooding the pen motivates the birds to stand. The time taken for each bird to lie down was recorded. This test was performed during day time and night time under light.

Two random litter samples were taken weekly from each of the pens by using a core sampler to analyze litter quality parameters such as bulk density (BD), true density (TD), moisture content and pH. Litter temperature was monitored daily by using a Hanna Pocket Thermometer.

Behaviour of each flock was recorded according to scan sampling method (Martin and Bateson, 1993) two days before sacrificing the birds. Observations were made continuously for 9 hrs during night time under the respective light environments and 5 hrs during day time. Each cage was visited four times an hour and the behaviour was recorded on ten (10) broad mutually exclusive categories, walking, standing, litter eating, drinking, eating, aggression, feather pecking, bird interaction, lying and dust bathing. From each visit of behaviour recording, one instantaneous observation was made on every bird and its behaviour in respective compartments as described by Slater (1978).

At the end of the experiment, the birds were slaughtered by neck dislocation. Right and left tibia of the birds that were subjected to 'latency to lie' test were analyzed for fat free ash according to the AOAC (1990).

Statistical analysis

The experimental design was a complete randomized design with six replicates.

Data were analyzed using analysis of variance (ANOVA) procedure in generalized linear model in the statistical package Minitab 14.1 1972-2003 (Minitab Inc.) (Ryan *et al.,* 1985).

RESULTS AND DISCUSSION

The performance of birds under different light environments are given in Table 1. As shown, the live body weight (BW) was not significantly affected by the colour of the light except for the day 21 measurement. However, broilers reared under red colour light showed a tendency ($P<0.08$) to gain higher body weight (1369 g) compared to those grown under white light

(1317 g). Feed and water consumption were almost similar in both light treatments. Feed and water intake parameters (day and night time feed and water intake, total feed and water intake, and total water to feed ratio) were not affected by the colour of lighting. Irrespective of the light treatment, the mean feed intake and water intake of the birds were ($P<0.05$) higher during day time compared to the night time. The birds exposed to red colour light, water to feed ratios were 1.4 and 1.8 during day time and night time, respectively. Under white colour condition, these ratios were 1.3 and 1.9, respectively. There was no significant difference in feed conversion ratio (FCR) between the two colour treatments. Prayitno *et al.* (1997) and Classen *et al.* (2004) also reported that there was no significant difference between colour treatments (blue, green, red, white) on final body weight, feed consumption and FCR. The authors further suggested that red light increased growth when it was provided at the beginning of rearing period, but growth decreased when provided at later stages. Rozenboim *et al.* (2004) found that birds exposed to blue or green light became significantly heavier than those exposed to red or white light. The results of the present experiment however matches with the findings of Atapattu and Wickramasinghe (2007) who reported high weight gain and FCR of broiler chicks under red light.

Results on LTL showed that birds under red light environment had higher LTL than those under white light environment (Table 2). Conversely, birds under white light during night time tend to have high LTL value during night time. However, overall LTL results showed that birds who were exposed to white light showed significantly ($P<0.005$) higher LTL (3.13 min.) than those exposed to red light in the night (1.61 min.). This overall LTL results were contradictory to the results of Lewis and Morris (1998) and Prayitno *et al.* (1997). Further, these results were not supported by the BW of the respective birds that were subjected to LTL test (1.74 and 1.77 kg for the white and red colour treatments, respectively). Behavioural studies also showed that there was no significant difference between the two treatments with respect to the parameters measured (Table 3). Though some studies (Weeks *et al.* 2002; Berg and Sanotra, 2003) suggested LTL as an appropriate indirect measurement to detect the leg strength/lameness, the results of this experiment do not support that suggestion. According to Lewis and Morris (1998), physical activity can stimulate bone development and it may improve the leg health of broiler chicken. During the present experiment, the birds received more than the standard spacing (±3 ft^2 / bird) recommended for broiler birds. Therefore, birds in this study had received considerable exercise both irrespective of the light environment. This may be the reason for the opposite results of the 'latency to lie' test during night.

There was no significant difference in leg circumference, length and tibia ash contents between the treatments. Tibia ash content showed no correlation with leg parameters considered in the study. Prayitno *et al*. (1997) also found that bone length, weight and torsion were not affected by the colour of light, but bone strength was significantly reduced in birds treated with red colour light. Though there was no significant difference between treatments of the present study, it could be suggested that under red colour light, bone mineralization may have been taken place to a great extent as indicated by tibia ash percentage (Table 2).

Prayitno *et al*. (1997) reported there was no difference in behaviour under red and white light conditions. The observation of the present study showed that there is no significant difference in night time behaviour under two colur environments except for drinking (Table

3). Lying down was the dominant behaviour exhibited under both treatments and the occurrence of it was significantly high (P<0.05) compared to the other behavioural traits. Shields *et al.* (2005) also reported that mature broilers spent more time on lying. According to Murphy and Preston (1988) broiler chickens become increasingly inactive as they reaches market weight, spending as much as 80% of their time resting. Prayitno *et al*. (1997) reported that drinking behaviour increased under red light condition. Atapattu and Wickramasinghe (2007) have also reported greater intake of water under red light compared to that under white light. Furthermore, Prayitno *et al*. (1996) also found that birds in the red and white lights were more active, compared to green and blue as evident from high walking activity of birds under white light and high floor pecking, wing stretching and aggression of birds under red light.

Table 1. The body weight (BW), weight gain (WG), average feed intake (FI), water intake (WI) and feed conversion ratio (FCR) of broilers reared under red and white colours of light during 14-36 days

Variable	Light colour		SEM	*p*
	White	Red		
BW g				
14 d	355.2	354.8	3.925	0.728
21 d	816.7	845.3	34.53	0.017
28 d	1339	1350	17.79	0.702
36 d	1673	1724	15.98	0.082
WG (g) 14-36 d	1317	1369	13.05	0.08
FI g				
Day time	130.9	134.5	4.60	0.59
Night time	53.0	55.2	1.69	0.37
Total	183.9	189.8	5.28	0.45
FCR	2.2	2.2	0.05	0.71
WI g				
Day time	170.4	188.2	6.20	0.07
Night time	100.8	100.5	2.73	0.93
Total	271.2	188.7	0.04	0.18
Water: Feed Ratio				
Day time	1.3	1.4	4.28	0.16
Night time	1.9	1.8	2.83	0.24

[1] Standard error of the difference between two means.

Table 2. The latency to lie (LTL) and leg characters of broilers reared under different light colour environments

Parameter	Treated Light colour		SEM[1]	*p*
	White	Red		
LTL (min)				
Day time (Under natural light)	0.93	2.55	0.56	0.05
Night time (Under artificial light)	3.72	2.29	0.55	0.08
Overall LTL result	3.13	1.61	0.34	0.005
Leg characters;				
Length (mm)	26.44	31.28	2.63	0.20
Circumference (mm)	56.69	56.04	5.53	0.37
Tibia Ash Content (%)	46.38	55.31	1.09	0.15

[1] Standard error of the difference between two means.

Table 3. Night time behaviour of broilers reared under red and white colour light environments.

Activity	*% birds*[1]		*SEM*	P
	Red Light	White Light		
Walking	3.00	2.60	0.61	0.652
Standing	5.73	5.86	0.89	0.918
Litter eating	2.60	4.16	0.66	0.104
Drinking	7.29	4.22	0.66	0.002
Eating	9.18	9.50	0.80	0.774
Aggression	0.13	0.39	0.20	0.365
Feather pecking	8.66	8.98	0.98	0.820
Bird interaction	0.98	1.24	0.40	0.650
Lying	61.26	63.04	1.64	0.447
Dust bathing	0.00	0.00	0.00	-

[1] Observation of eight birds

The birds which received white colour light during night spent more time lying down during day time than those who received red colour light during night. On the other hand, feather pecking and dust bathing behaviours were higher among the birds which received red light during night.

It is interesting to note that the colour of the light provided during night time influenced the day time behaviour of the birds (Table 4).

CONCLUSIONS

Results of the present study showed that rearing broiler chicken in red or white colour lights at 20 lux intensity during night time in a hot, humid tropical environment has no effect on growth performance. However, colour of light affects the behaviour and latency to lie.

Accordingly, the colour of the light during night influence birds' behaviour more than its growth.

Table 4. Day time behaviour of broilers exposed to red and white colour lights during night time

Activity	% birds		SEM[1]	*P*
	Red light	White light		
Walking	1.48	1.29	0.436	0.768
Standing	4.34	3.21	0.692	0.255
Litter eating	2.17	1.45	0.468	0.282
Drinking	4.77	5.11	0.748	0.755
Eating	9.00	7.02	0.844	0.103
Aggression	0.17	0.09	0.137	0.657
Feather pecking	5.37	2.96	0.716	0.022
Bird interaction	0.17	0.00	0.123	0.323
Lying	68.88	77.31	1.531	0.000
Dust bathing	3.65	1.56	0.571	0.013

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