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Preference of Broiler Chicken for Different Light Colors in Relation to Age, Session of the Day and Behavior

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ABSTRACT. *Preference (PR) of broilers (Cobb) for four different Light Colors (LC); red [RD], white [WT], green [GN] and blue [BL]; 5 W at 20 lux were tested on group level at 3-5 wks of age (AG) in the morning (MN), evening (EV) and night (NT) sessions of the day (SD). Six replicates of 5 birds were each allowed to move freely between 4 compartments illuminated continuously with a 4 hr light break. After one day of habituation to the test pen, location and behavior of birds were recorded once every 15 min. over 18 hrs/week. Twenty, mutually exclusive behaviors were assessed. Up to 21 days, no special PR was recorded. During the 3^rd^ week, significantly high ($p<0.05$) PR was recorded (29.42 %±7.07) in RD while GN recorded the least (5.75 %±6.98) in the NT. At 4^th^ week also the highest (33.33 %±21.6) and the lowest (9.44 %±13.35) PRs were recorded in RD and GN, respectively. During 14-21 days, the highest eating [ET](18.34 %±10.99) was recorded by BL, drinking [DR](12.16 %±2.13) and scratching floor[SF](4.9 %±5.5) by WT in the NT; walking (27.76 %±25.25) and bird interaction [(BI](2.5 %±6.1) by RD and BL, respectively in the MN; lying[LY](58.42 %±19.45) by WT, wing flapping[WF](1.7 %±4.2) by BL, and sleeping[SL](18.88 %±21.5) by RD in the EV. During 4^th^ week LC had an interaction effect (IE) with SD on walking, dust bathing (DB), wing/leg stretching (WLS) and SF. LC and SD separately had a significant ($p<0.05$) effect on ET and SL where DR only influenced by LC. At 5^th^ week only ET, DR, LY and DB had an IE while WF was only affected by LC. Above results have shown that certain behaviors changed with the LC, AG, SD and their IE where standing and BI significantly decreased with the AG. These results support the notion that broilers prefer RD LC in the NT under tropical environment. There sensitivity for LCs could be seen only after 21 days. RD and WT LCs are prefered more than the BL and GN. Associated Behaviors were significantly affected by the LC, SD and AG.*

Key words: *Animal welfare, behavior, broiler, color preference, light*

INTRODUCTION

Light is arguably the most important stimulus that the domestic fowl, *Gallus gallus domesticus*, receives from the physical environment (Perry & Lewis, 1993). Its manipulation, whether through photoperiod, intensity, source or wavelength has profound effects upon the physiology and behavior of fowl (Manser, 1996). The fact that the fowl have preferences (PR) for different light environments has been shown by various researchers (Savory &

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Duncan 1982/83; Appleby *et al*., 1984; Alsam & Wathes 1991; Widowski *et al*., 1992). In recent years, most research on the relationship between lighting and behavior in poultry has followed two approaches; PR tests and behavioural observations of broilers within their given light environment. The PR of poultry have been assessed for different light intensities (Davis *et al*., 1999), light sources (Widowski *et al*., 1992; Vandenberg & Widowski, 2000), light colours (Prayitno *&* Philips, 1997) and flickering frequencies (Widowski & Duncan, 1996). In short, these studies have shown that hens prefer compact fluorescent to incandescent light sources (Widowski *et al*., 1992) and show no PR between compact fluorescent light sources of different flicker frequencies (Widowski & Duncan, 1996) or between high-intensity high-pressure sodium over low-intensity incandescent lights (Vandenberg & Widowski,2000). Broilers reared in white (WT), red (RD) or blue (BL) light (30 lux) during 7-28 days of life subsequently preferred BL light after 1 wk of exposure, whilst birds reared in BL light preferred GN light after 1 week of exposure (Prayitno *et al*., 1997a). The above studies provide valuable information about the ability of domestic fowl to choose identical environments on the basis of light.

PR testing provides an important tool in animal welfare research and gives insight into what the animals want in a given situation. However, the social nature of broilers also causes birds in a group, thus, influencing choice of each other. Hence, testing the PRs of broiler chickens in a group will necessitate the use of more birds than testing them individually. The previous experience of an animal will probably affect its PRs. In poultry, the familiar resource is often preferred initially, although this PR may change with time and experience of other resources. It may therefore be important to ensure that all the resources are equally familiar to the broilers before enabling them to choose between them (Davis *et al*., 1999).

Although the beneficial production consequences of the broiler production systems are well known, little consideration has been given to the requirements of broilers for appropriate illuminance to perform particular behavior. Davis *et al*., (1999) showed that immature domestic fowl exhibits an apparent PR to perform certain behaviours in particular illuminances. Locating, selecting and manipulating food prior to ingestion is considered to be highly dependent upon vision, and previous studies have shown that fowl spend more time on eating [ET] (Savory & Duncan 1982/83; Davis *et al*., 1999).

The aim of this investigation was to determine what PRs, if any, modern broilers show among a range of different light colours [LCs]; (Red [RD], white [WT], green [GN] and blue [BL]) on group basis, and whether such PRs are influenced by age [AG] (at 3 vs 5 wk), session of the day (SD) [morning (MN) vs. evening (EV) vs. night (NT)] and behavior. A better understanding of lighting PRs would help in the development of management practices and guidelines that are best suited to poultry welfare.

MATERIALS AND METHODS

Animals and rearing environment

A total of 30-d old broiler chicks of strain Cobb were used. Up to 14 d, the chicks were brooded in a brooder guard under two, 40W normal incandescent light bulbs. Lighting was continuous at 60 lux intensity for the brooding period. Light intensity was measured by angling the cosine-corrected photoreceptor sensor of a light meter (Macam Photometer, Model L 103; Macam Photometrics Ltd. Livingston, UK) in the direction of maximum radiance at eye level of the bird (25 cm above the litter) according to the method defined by Tucker and Charles (1993).

Preference test

The experiment was conducted in six Foraging-Social Mazes (FSM) type experimental units (Fig 1) described by Schutz *et al.*, (2002). Four identical, specially constructed mazes which were illuminated with four different LCs; RD, BL, GN and WT were used as one FSM which consisted of four, identical interconnecting compartments arranged in an annular form. Each compartment was rectangular in shape measuring 3 ft. long x 2 ft. wide x 3 ft. high, and one central box measuring 2 x 2 x 3 ft^3, arranged as in a plus maze. Central box facilitated access to the adjacent compartments. Each compartment was provided with a feeder and a bell shaped drinker to ensure *ad libitum* feed and water, and paddy husk was used as the litter material. Wire meshes were attached to the frame together with the black polythene that was just outside the arena. LCs were provided by using 5 W incandescent bulbs at 20 lux intensity.

Initially birds were coloured at different places on the body for easy identification. They were weighed and kept in the central box for 24 hours which was confined with a wire mesh (5 birds/ experimental unit). It was provided with a small bell shape drinker and a trough feeder. After 24 hrs of habituation, the feeder, drinker and the wire mesh were removed. Then birds were allowed to freely move according to their PR for the LCs. Artificial light was provided for 20 hrs (from 10 p.m. to 6 p.m. of the following day) with a dark period (from 6 p.m. to 10 p.m.). Presence and behaviour were recorded at every 15 min. for consecutive 2 hours during MN (9-11a.m.), EV (2-4 p.m.) and NT (10 p.m.-12 midnight). Four visits/hour/experimental unit were made using scan sampling method (Martin & Bateson, 1993). Behaviour of the birds under different LCs was studied using an ethogarm. At 35 d, birds were weighed individually and humanely slaughtered them at 36 d of their age. Simultaneously the presence under respective LC with the behaviour of five birds was evaluated in each of the FS.

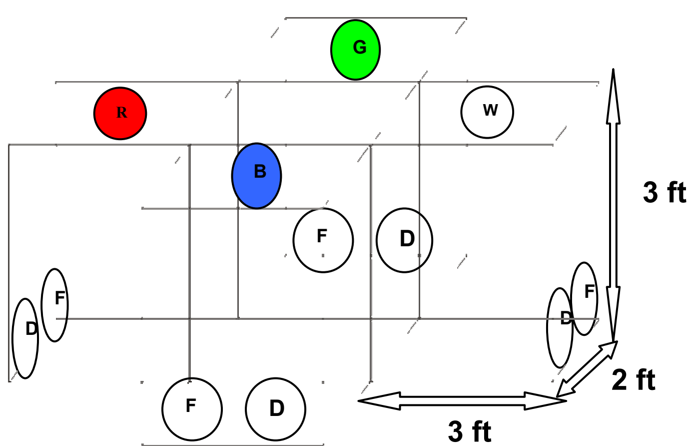

Fig. 1. Experimental design

Light sources: R-Red, B-Blue, G-Green,W-White
F-Feeder, D-Drinker

Statistical analysis

The total presence in the four light environments by 6 blocks (replicates) and respective behaviours were analysed by ANOVA, using the Statistical Analysis Software (SAS, SAS Institute Inc. Release 9.1). The difference between treatment means was examined by including treatment, AG, SD as main effects and all two way interactions. Effect of the AG was compared by adopting pooled t-test using SPSS package.

RESULTS AND DISCUSSION

Total occupancy

Results of this investigation indicate that broiler chicks of commercial strain of Cobb shows significant PRs when allowed to choose among a range of different LCs. The total percentage time spent in particular LCs at different SD is shown by Table 1.

Table 1. Significant effect of AG, SD and LC on the presence in particular LC (Data taken from ANOVA, n=90) not significant=ns p>0.05; significant p<0.05)

Age/Session	Presence in different light colours (%)					*p*
	Red	White	Green	Blue	No light	
14-21d						
M	19.31[a]±28.71	21.11[a]	23.06[a]	17.92[a]	22.09[a]	ns
		±17.59	±17.75	±16.07	±9.38	
E	14.99[a] ±19.30					ns
		19.03[a]	12.64[a]	27.92[a]	22.36[a]	
N	24.59[a] ±9.29	±21.03	±9.52	±28.93	±10.54	ns
22-28d		25.69[a]	5.56[a] ±8.62	24.58[a]	20.00[a]	
		±15.38		±15.57	±13.91	
M	22.25[a] ±10.61					ns
E	15.92[a] ±25.91		14.42[a]			ns
		17.42[a]	±7.07	15.25[a]	30.17[a]	
N	29.42[a,b] ±7.07	±6.95		±6.77	±4.06	0.027
			18.50[a]			
		33.92[a]	±15.18	15.46[a]	16.08[a]	
		±25.85		±8.94	±7.08	
28-35d			5.75[c] ±6.98			
		15.92[a,b]		12.35[b,c]	34.92[a]	
M	21.53[a] ±11.46	±12.85		±5.62	±8.28	ns
E	16.67[a] ±23.58					ns
N	33.33[a] ±21.60		11.94[a]			ns
			±3.89			
		17.50[a]		23.06[a]	24.44[a]	
		±13.01	14.48[a]	±18.41	±07.20	
			±21.33			
		32.92[a]		27.15[a]	08.01[a]	
		±32.72	9.44[a]	±18.45	±05.59	
			±13.35			
		16.70[a]		10.42[a]	23.12[a] ±10	
		±8.32		±12.02		

M=morning; E=evening; N=night

Up to 21 d, there was no special PR for any LC. At the 4th week LC PR was dependent on the SD where the highest PR was recorded for RD and the lowest PR was recorded in GN. Senaratna *et al*. (2010) also found that LC PR of broilers is significantly affected by the AG of the birds and the SD on an individual animal basis under same management and environmental conditions. This apparent reversal of overall PR was mainly due to changes associated with the 8 activities, i.e. drinking (DR), walking (WK), standing (ST), lying (LY), litter eating (LE), bird interaction (BI), scratching floor (SF) and dozing (DZ) [Table 5].

Davies *et al.* (1999) and Kristensen *et al*. (2006) used groups of broiler chickens whereby given a choice of four different, equally familiar light environments [for light intensities, Davies *et al. (*1999) and for light colours, Kristensen *et al*. (2006)] over a period of 6-10 d at two ages (1-2 and 5-6 wk). In both experiments, the broilers chose differently at the two AGs, suggesting a shift in PR for both light intensity and LC between the beginning and the end of the growing period. Reviewed literature showed that the birds' eye development takes place with the AG thereby showing a sensitivity or a PR for a special colour. Up to 5th week still marked the highest PR for RD but no significant difference was recorded with the other LCs. The reason may be during this week there was an unusual cool climatic condition prevailed (average T^{o}=23.5^{o}C, according to meteorological records for Mapalana) which affects the flock cuddling together over the effect of LC. Kristensen *et al*., 2006 also mentioned after two experiments that broilers have a PR for certain light sources at six weeks, but not at 1 week of AG. There may be several reasons for the lack of light PR in 1 wk-old broiler chickens. It could be argued that in the wild, young chicks would be led by the hen and hence may not yet possess the ability to choose actively between light environments. Neurobiological studies have shown that one week old chicks have not completed the neural development of the visual cortex (Rogers, 1994) and young chicks show AG-dependent lateral asymmetry in response to visual stimuli (Regolin & Vallortigara, 1996). However, a PR for visual complexity has been shown as early as in 5-6 d old chicks (Berryman *et al*., 1971).

Associations between light colours and behavior

Both LC and SD influenced the behavior of domestic fowl (Table 2, 3 and 4). Some of the defined 17 behavioural categories were observed to be significantly depend on the LC, SD and the AG of the birds. During 14-21 d, the highest values were recorded for ET (18.34±10.99 %)by BL, DR (12.16±2.13 %) and SF (4.9±5.5 %) by WT in the NT, WK (27.76±25.25 %) and BI (2.5±6.1 %) by RD and BL respectively in the MN, LY (58.42±19.45 %)by WT, WF (1.7±4.2 %)by BL and SL (18.88±21.5 %) by RD in the EV (Fig. 2). It was also found that exposure to light stimulus is known to induce behavioural arousal (movement) and desynchronization of the electroencephalogram (physiological arousal) in rats (Sakai *et al*., 1996).

Table 2. Effect of LC and SD on the presence (14-35 d) and behavior during 14-21 d

Presence/behaviour	Time period/Session (S)	Light colour (C)	Interaction (CxS)
Presence			
14-21d	ns	ns	ns
22-28d	ns	***	**
29-35d	ns	ns	ns
Eating	***	***	***
Drinking	ns	**	**
Walking	ns	***	**
Standing	ns	ns	ns
Preening	ns	ns	**
Lying	**	***	**
Litter Eating	**	ns	ns
Dust Bathing	ns	ns	ns
Bird Interaction	**	**	***
Wing Flapping	ns	**	ns
Vocalization	ns	ns	ns
Wing/Leg	ns	**	ns
Stretching	***	ns	ns
Sleeping	ns	ns	**
Scratching Floor	***	ns	ns
Dozing	n/a	n/a	n/a
Idling	ns	Ns	ns
Other			

* * p<0.01; * * * p<0.001;ns not significant=p>0.05; n/a-not applicable

During 3rd and 5th weeks, there was no significant interaction with SD for the presence under respective LC. However, during 4th week, LC showed a significant interaction with the SD (Table 2). In addition ET, DR, WK, Preening (PRE), LY, BI and SF behaviours showed an interaction with the time and the LC.

Laying hens showed more PRE behavior in compact fluorescent light than incandescent light (Widowski *et al*., 1992) and performed more nesting, PRE, ground pecking and DR in high pressure sodium light of high intensity than in incandescent light of low intensity (Vandenberg & Widowski, 2000)

During 4th week LC had an interactive effect with the SD on WK, DB, WLS and SF behaviours (Table 3). Though there was no interaction effect on ET and SL behaviours, LC and the SD separately had a significant effect on them while DR had only influenced by the LC. During 5th week, ET, DR, LY and DB behaviours showed an interaction effect among LC and SD (Table 4). WF only affected by LC. WK, PRE, LE, SL, DZ and other behaviours only affected by the SD. Above results show that the interaction effect on certain behaviours vary with the AG of the birds (Table 5).

Table 3. Effect of LC and the SD upon the behavior during 22-28 d

Behaviour	Time period/session (SD)	Light colour (C)	Interaction (CxS)
Eating	***	***	ns
Drinking	ns	***	ns
Walking	ns	ns	**
Standing	ns	ns	ns
Preening	**	ns	ns
Lying	ns	ns	ns
Litter eating	***	ns	ns
Dust bathing	**	***	**
Bird interaction	ns	ns	ns
Wing flapping	ns	ns	ns
Vocalization	n/a	n/a	n/a
Wing/leg stretching	**	**	***
Sleeping	**	***	ns
Scratching floor	**	**	**
Dozing	***	ns	ns
Idling	ns	ns	ns
Other	ns	ns	ns

* * p<0.01; * * * p<0.001; not significant=ns p>0.05; n/a-not applicable

Table 4. Effect of LC and SD upon the behavior during 29-35 d

Behaviour	Time period/session (S)	Light colour (C)	Interaction (CxS)
Eating	***	***	**
Drinking	ns	***	**
Walking	**	ns	ns
Standing	ns	ns	ns
Preening	**	ns	ns
Lying	***	***	**
Litter eating	**	ns	ns
Dust bathing	**	***	***
Bird interaction	n/a	n/a	n/a
Wing flapping	ns	***	ns
Vocalization	ns	ns	ns
Wing/leg stretching	ns	ns	ns
Sleeping	***	ns	ns
Scratching floor	ns	ns	ns
Dozing	***	ns	ns
Idling	ns	ns	ns
Other	**	ns	ns

* * p<0.01; * * * p<0.001; not significant=ns p>0.05; n/a-not applicable

Table 5. Mean (±SD) proportion of time (percentage) spent in different behaviours at 3- 5 weeks

Presence/ behaviour	3rd week	vs. 4th week	P[1]	4th week	vs. 5th week	P[2]
Presence	20.06±5.67	19.85±8.5	0.94	18.95±9.4	19.38±8.03	0.89
Eating	7.75±7.15	9.88±7.28	0.43	9.57±7.44	12.72±9.5	0.32
Drinking	3.69±3.31	6.85±4.75	0.04	6.32±4.59	5.78±4.24	0.74
Walking	6.11±6.48	2.35±2.35	0.04	2.49±2.39	2.33±1.85	0.83
Standing	7.21±3.99	4.90±4.75	0.16	4.94±4.74	2.39±1.99	0.05
Preening	7.17±3.49	6.67±3.92	0.71	6.47±3.98	6.49±3.12	0.98
Lying	39.07±16.41	50.37±9.2	0.03	47.29±15.14	44.71±12.38	0.61
Litter eating	4.99±2.89	2.22±1.69	0.03	2.28±1.73	2.45±1.77	0.78
Dust bathing	0.89±1.43	0.77±1.62	0.82	1.02±1.81	1.25±3.07	0.80
Bird interaction	0.91±1.89	0.73±1.13	0.76	0.99±1.39	0.00±0.00	0.01
Wing Flapping	0.66±0.93	0.51±0.57	0.61	0.77±1.05	0.22±0.42	0.07
Vocalization	1.87±7.23	0.00±0.00	0.33	0.27±1.03	1.00±3.87	0.34
Wing/leg stretching	1.36±1.41	1.02±1.29	0.49	1.26±1.48	1.07±1.16	0.69
Sleeping	6.17±5.89	8.83±6.80	0.26	8.33±6.86	5.17±4.86	0.61
Scratching floor	1.25±1.51	0.11±0.43	0.01	0.37±1.09	1.73±6.71	0.21
Dozing	0.78±0.86	3.39±3.51	0.01	3.61±3.4	2.74±2.69	0.44
Idling	0.00±0.00	4.46±0.17	0.33	0.90±1.10	9.93±0.26	0.45
Other	1.21±1.94	0.68±0.69	0.33	0.31±1.03	1.34±1.79	0.43

P [1,2] p value from pooled t-test (n=15)

Though DR, WK, LY, LE, SF and DZ behaviours significantly different between 3rd and 4th weeks, that effect could not be seen between 4th and 5th weeks. Similarly, ST and BI behaviours were significantly different between 4th and 5th weeks, and were not significant during 3rd and 4th weeks. ST and BI behaviors significantly decreased with the AG.

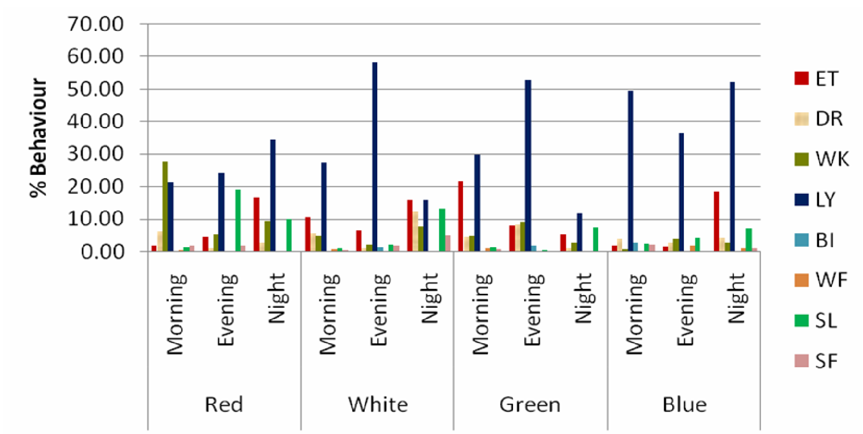

Fig. 2 Significantly different (p<0.05) behaviors among different LC environments during 14-21days

During 22-28 d (Fig.3), certain behaviours showed significant difference ($p<0.05$) where the highest ET (25.41±13%) and SL (12.17±12.8%) behaviours were recorded by WT in the NT. Birds were more active in RD which was proved by the highest DB (1.68±2.5%) and WLS(2.14±4.0%) performed by RD in the MN. Under GN also WLS showed the same results (2.14±4.0%) in the NT (Fig.3). Early findings also proved that broiler birds were more active in RD (more ground pecking, wing stretching and aggression) and WT light (more WK) than in GN or BL light of 30 lux between 7 and 28 days of AG. Bright RD light increased WK, feeding and stretching behavior (Prayitno *et al*., 1997). Davis *et al*., (1999) found that broilers spent more time DR, performing litter-directed behavior and feeding in bright light (200l ux), whereas Vandenberg and Widowski (2000) found more feeding behavior in incandescent light of low-intensity. LY behaviour was not influenced by LC in this study. Kristensen *et al*., (2006) also found that sitting behaviour was not influenced by light source or intensity.

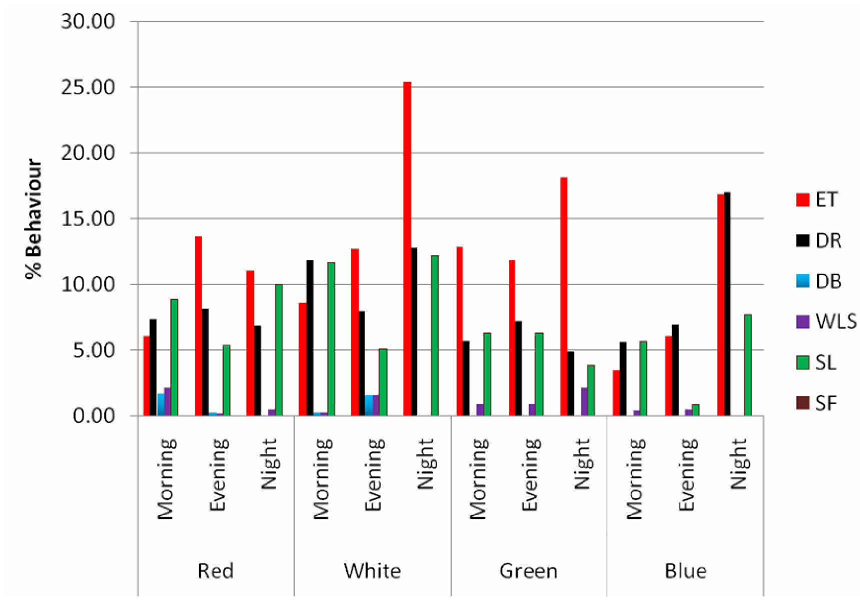

Fig. 3. Significantly different ($p<0.05$) behaviours among different LC environments during 22-28d

During 29-35 d (Fig. 4) the highest ET and DR behaviours were shown by RD and BL, respectively in the EV whereas the highest DB, WLS, and SL were performed by WT in the MN.

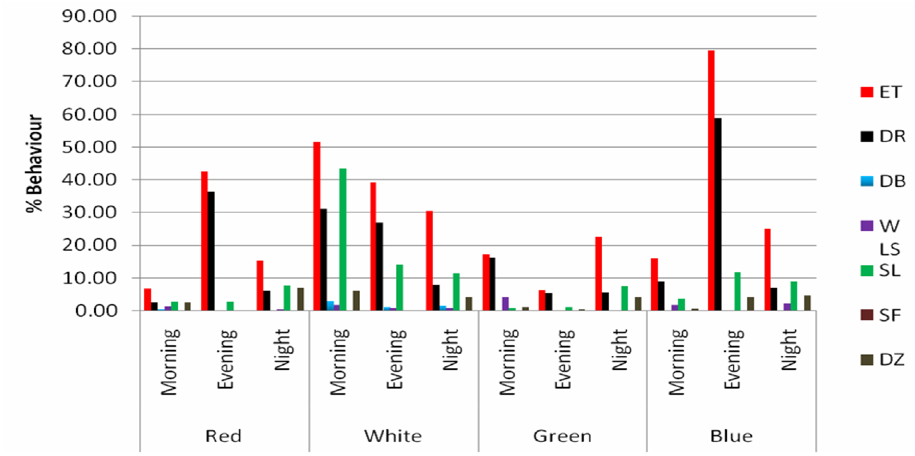

Fig. 4. Significantly different ($p<0.05$) behaviours among different LC environments during 29-35d

CONCLUSIONS

Broilers prefer RD colour light in the NT. Their sensitivity for colour lights can be expected after 21 days. RD and WT colour lights prefered more than the BL and GN. It was observed that the associated behaviours also depend on the AG and the SD under tropical environmental conditions .

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