



## The Influence of Side-Curtain Color on Broiler Chick Behavior

### ■ Author(s)

Vercellino R do A<sup>1</sup>  
Moura DJ de<sup>1</sup>  
Nääs I de A<sup>1</sup>  
Maia AP de A<sup>1</sup>  
Medeiros BBL<sup>1</sup>  
Salgado DDA<sup>1</sup>  
Carvalho TRM de<sup>1</sup>

### ■ Mail Address

Corresponding author e-mail address  
Rimena do Amaral Vercellino  
<sup>1</sup> Faculdade de Engenharia Agrícola  
Av. Candido Rondon, 501 - Barão Geraldo  
- Campinas /SP - Cidade Universitária  
Zeferino Vaz - CEP 13083-875  
Email: rimena.vercellino@gmail.com

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### ABSTRACT

Brazilian poultry production is prospering, and negative-pressure broiler houses are increasingly used to improve environmental control. One important issue is the color of the side curtains used in such houses due to the influence of colors on broiler behavior. This study aimed at evaluating the influence of different curtain color on the welfare of 7-day-old broilers, considering luminosity and other environmental parameters. Chicks were housed in three different negative-pressure broiler houses either with black (T1), blue (T2), or yellow (T3) side curtains. House environment (luminosity, dry-bulb temperature, air relative humidity, air velocity, and gas emissions) and the behavior of chicks on day 7 after housing were evaluated in three consecutive flocks in the morning and in the afternoon. Data were submitted to multivariate analysis, Kruskal-Wallis' test, and Pearson's correlation test. Luminosity and ITU were influenced by curtain color, and some of the evaluated behaviors were associated with luminosity or other environmental parameter.

### INTRODUCTION

In Brazil, the poultry industry applies modern technologies more than any other animal production activity (Lima *et al.*, 2011). Modern broiler genetic strains have high performance genetic potential; however, proper conditions should be provided to allow birds to fully express this potential and to profit from their better productivity. One essential requirement is proper environmental control. Negative-pressure broiler houses provide a better environment and therefore are increasingly used.

In commercial poultry production, the color of the curtains used to close the sides of the conventional poultry houses has been discussed lately, particularly relative to the light intensity they allow inside. Poultry are more sensitive to environmental luminosity than humans (Lewis & Morris, 2000; Prescott & Wathes, 2001). However, the behavior of poultry is influenced by environmental factors other than luminosity (Dawkins, 1999; Ferrante *et al.*, 2001), and understanding the effect of the environment on behavior allows identifying, quantifying, and characterizing thermal comfort and welfare conditions (Pereira *et al.*, 2007). According to SCAHAW (2000), behavior is the leading means animals have to express their physical and mental states. Some researchers (Payne, 1967; Sturkie, 1967; Pereira *et al.*, 2005; Silva *et al.*, 2006; Salgado *et al.*, 2007; Weeks & Nicol, 2006; Alvino *et al.*, 2009) mention that deviations or restriction of behaviors expressing physical activity (spreading wings, running, lying, standing, stretching, etc.), drinking and feeding, as well of the natural behavior of poultry (pecking, dust bathing, preening) may be considered stress indicators.



The absence or presence of these behavior suggests poultry welfare status. In broilers, the first two weeks of life are the most critical, as management mistakes will have a strong impact on their final performance (Butcher & Nilipour, 2002). According to Blockhuis & Wiepkema (1998), many welfare problems observed in adult poultry result from problems in the rearing environment during the first week of life.

The objective of this study was to evaluate the behavior of seven-day-old broiler chicks reared in poultry houses with side curtains of different colors in order to determine which provides the best welfare conditions.

## MATERIALS AND METHODS

The experiment was carried out in three commercial broiler houses. Two were located in the municipality of Tietê, SP (latitude 23° 06' 07" S, longitude 47° 42' 53" O, altitude 508 m) and other located in Cerquilha, SP (latitude 23° 09' 54" S, longitude 47° 44' 37" O, altitude 595 m), all in Brazil. The climate of these two municipalities is classified as Cwa (wet temperate climate, with dry winters and hot summers), according to Köppen's climate classification (1936). The experiment was carried out between March and August, 2011, totaling three flocks evaluated per broiler house.

### Broiler house characteristics

The three evaluated houses were 150m long, 14m wide, and 3m high, and built in the east-west direction. The houses were equipped with negative-pressure ventilation and automatic feeding, drinking, and brooding systems. All houses had concrete floors, which were covered with wood-shavings litter in Tietê (rearing density of 14.7 birds m<sup>-2</sup>) and with sawdust in Cerquilha (rearing density of 14.5 birds m<sup>-2</sup>).

Treatments consisted of black side curtains (dark house, T1); blue side curtains (blue house, T2), or yellow side curtains (T3). T1 and T3 houses were located on the same farm, at the municipality of Tietê, whereas T2 house was located at the municipality of Cerquilha.

### Experimental procedures

Behavior was monitored when broilers were seven days of age through a video camera (Sony®, model SR68) placed on a tripod located at the center of the brooding circle in an angle that allowed recording the birds (Figure 1).

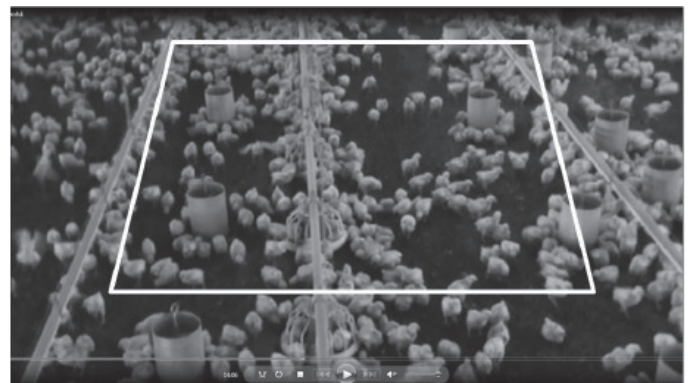


Figure 1 – Diagram of the area used for the behavioral analysis in all treatments.

Bird behavior was recorded in the morning and in the afternoon for 15 minutes, according to the methodology proposed by Bizeray *et al.* (2002). The following environmental parameters were collected at bird height and at the same location and time of behavior recording: luminosity (L, in lx), dry bulb temperature (DBT, in °C), air relative humidity (RH, in %), air velocity (AV, in ms<sup>-1</sup>), ammonia concentration (NH<sub>3</sub>, in ppm) and carbon dioxide concentration (CO<sub>2</sub>, in ppm). Luminosity and relative humidity were measured using a digital multifunctional device (Instrutherm®, model THDL-400), temperature and air velocity were collected using a thermo-anemometer (Extech®, model 407123), and NH<sub>3</sub> and CO<sub>2</sub> a gas detectors (BW® Technologies, model GasAlert Micro5 IR). External temperature (DBT\_EXT, in °C) and relative humidity (RH\_EXT, in %) were recorded using a mini data logger (Onset®).

Using dry bulb temperature and relative humidity data, the temperature and humidity index (THI) was calculated according to equation 1, proposed by Thom (1959). Values between 64 and 74 are considered as "comfortable"; between 74 and 78, "warning"; and higher than 78, "dangerous".

$$THI = DBT + 0.36Tdp + 41.5$$

where

THI – temperature and humidity index;

DBT – dry bulb temperature, in °C; and

Tdp – dew point temperature, in °C.

An ethogram, based on Campos (2000), Pereira (2005), and Neves *et al.* (2005) was adopted (Table 1).

Behavioral data were analyzed according the method of instantaneous scanning proposed by Altmann (1974) and used by several authors in different animal behavior studies (Itavo *et al.*, 2008; Albuquerque & Codenotti, 2006; Passos & Alho,



2001). In each recording, birds were randomly selected and the frequency of each behavior displayed during each recording was calculated (Table 1).

**Table 1** – Bird ethogram.

BEHAVIOR	DESCRIPTION
Wing flapping	Movement in which the birds flaps both wings
Feather ruffling	Birds ruffle all their feathers
Litter pecking	Birds peck the litter with their beak
Running	bird moves between two points faster than normally observed
Lying	the bird remains sitting or lying on the litter
Stretching	The bird stretches the wing and the leg of the same side of the body
Preening	The bird cleans and aligns its feather using its beak
Dust bathing	The bird throws litter substrate on its body
Eating	The bird positions itself in front of the feeder and ingests feed
Drinking	The bird positions itself in front of the drinker and drinks
Standing	The bird remains standing, and does not perform any activity
Threatening	The bird places itself on front of another bird, with its neck stretched, ruffles its feathers, stretches both wings, and looks at the bird downwards
Pecking	One bird aggressively pecks any part of the body of another bird
Chasing	One bird chases another bird

## STATISTICAL ANALYSIS

Principal Component Analysis (multi-variate analysis) was used to evaluate possible associations among behaviors of birds in the different treatments. Box plots and the test of Kruskal-Wallis at 5% significance level were used to make comparisons. Pearson's correlation test was applied to verify possible interactions between the environmental parameters and behavioral frequencies. All statistical analyses were performed using the software package MINITAB® 15.1 (Minitab, 2005).

## RESULTS AND DISCUSSION

Results are discussed in two different sections: rearing environment and chick behavior.

### Rearing environment

Optimal environmental values required by seven-day-old Cobb broilers, according to Cobb management manual (2008), Barnwell & Wilson (2005), and Globalgap (2007) are shown in Table 2.

**Table 2** – Optimal environmental parameter values for seven-day-old broilers.

Parameter	7 days
DBT (°C)	29 - 30
RH (%)	30 - 50
Vair (ms <sup>-1</sup> )	< 0.5
CO <sub>2</sub> (ppm)	< 3000
NH <sub>3</sub> (ppm)	< 10

DBT – dry bulb temperature. RH = Relative humidity. Vaie = air velocity.

According to the test of Kruskal-Wallis, luminosity was significantly different ( $p < 0.05$ ) among treatments, with the highest luminosity in T3 ( $68.70 \pm 20.30$ ), followed by T2 ( $18.75 \pm 2.87$ ) and T1 ( $5.13 \pm 0.53$ ), as shown in Figure 2. Figure 2 also shows that luminosity in the T3 house was less uniform compared with the other treatments. THI was within the recommended limit only in T2 house ( $73.00 \pm 0.41$ ) and was significantly different from the other treatments, which was  $77.17 \pm 1.01$  for T1 and  $76.83 \pm 0.87$  for T3, representing a “warning” situation.

There were no differences among treatments ( $P > 0.05$ ) for the other environmental parameters. Relative humidity, air velocity, and CO<sub>2</sub> level were within the limits recommended by literature in all treatments (Table 2), although dispersion was wider in terms of air velocity in T2 and of CO<sub>2</sub> level in T1 (Figure 2). Temperature was maintained within the desired limits in T1 and T3 (Table 2), and T2 presented less variation (Figure 2). Only T2 maintained adequate NH<sub>3</sub> levels (Table 2). External temperature was less variable in T2, whereas external relative humidity was less variable in T3 (Figure 2).

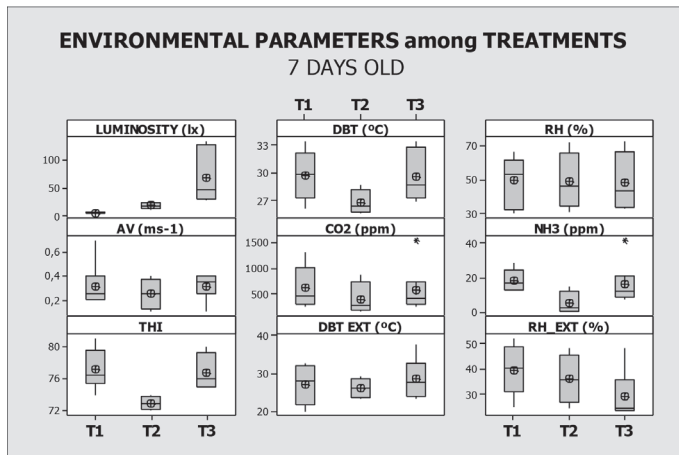


Figure 2 – Box plot of the environmental parameters among treatments when broilers were seven days old.

### Behavioral activity

The results of the multi-variate analysis (Figures 3, 4, 5) showed that treatments T1 and T2 (Figures 3 and 4, respectively) explained 60% of total data variation and treatment T3, 64% of the variation (Figure 5). Positive correlations of the behaviors lying with T1, running and scratching with T2, and threatening and chasing with T3. On the other hand, wing stretching and ruffling feathers were negatively correlated with T1, lying with T2, and standing with T3. This indicates that the incidence of behaviors related to physical activity is lower when the environment is darker, as in T1. According to Randall *et al.* (2000), the capacity of responding to light is a universal aspect of all organisms, and therefore, luminosity is the main stimulus to adjust or to change the cycle activity-rest.

Prescott *et al.* (2004) and Blatchford *et al.* (2009) observed that dark environments may have adverse effects on broiler behavior because of vision impairment. However, according to Hester (2005), darkness reduces the incidence of aggressive encounters due to visual impairment, which may explain why the lightest environment (T3) presented a higher frequency of behaviors associated to aggressiveness. It must also be noted that there was greater luminosity variability in T3 compared with T1 and T2 (Figure 2).

Kristensen *et al.* (2007) evaluated the movement of broilers in environments first with different light intensities (5 and 100lx) evenly distributed along one photoperiod, and did not observe any behavioral differences between light intensities. However, when light intensity varied during the photoperiod, birds were less active when was applied compared with those maintained at 100lx. Behaviors related to physical

activity are indicators of animal health and welfare and are required for adequate broiler performance (Schwean-Lardner & Classen, 2010).

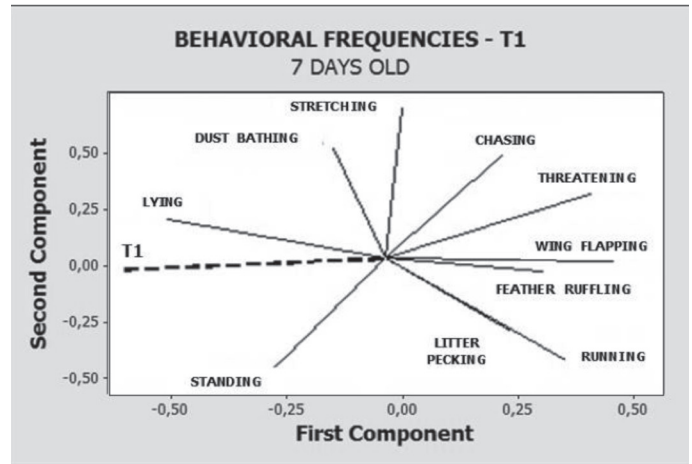


Figure 3 – Graph of the principal components of behavioral frequencies observed in T1 when broilers were seven days old.

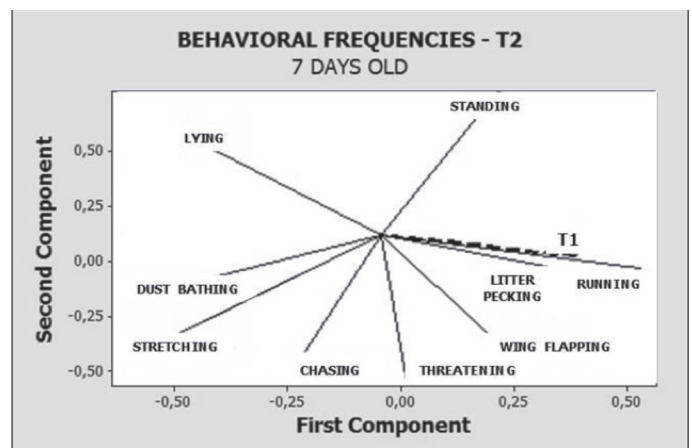


Figure 4 – Graph of the principal components of behavioral frequencies observed in T2 when broilers were seven days old.

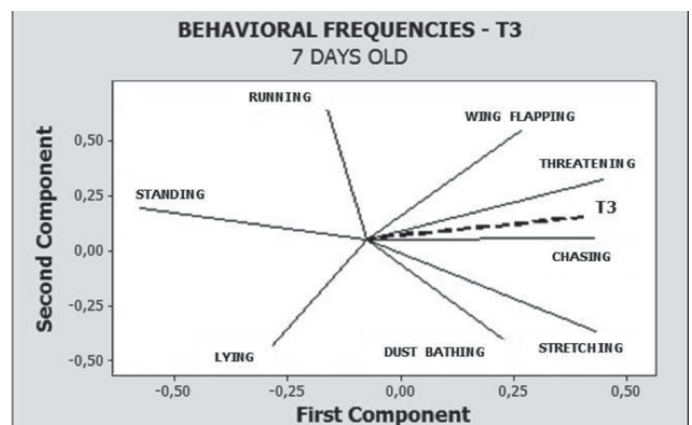


Figure 5 – Graph of the principal components of behavioral frequencies observed in T3 when broilers were seven days old.





Running, lying, and drinking frequencies differences among treatments were related to luminosity, as determined by the test of Kruskal-Wallis ( $p < 0.05$ ), or to environmental parameters, according to Pearson's correlation test ( $p < 0.05$ ), as shown in Table 3. The frequencies of the other evaluated behaviors were not different among treatments or were not correlated with environmental variables.

**Table 3** – Significant Pearson's correlation test between environmental parameters and behaviors of seven-day-old broilers

environmental parameter		Running	Lying	Drinking
IL (lx)	Correlation	-0.13	-0.32	0.49
	P value	0.63	0.23	0.04
DBT (°C)	Correlation	<b>-0.72*</b>	0.62	0.30
	P value	0.00	0.01	0.25
RH (%)	Correlation	0.37	-0.59	-0.07
	P value	0.16	0.02	0.79
Vair (ms <sup>-1</sup> )	Correlation	-0.49	0.18	-0.09
	P value	0.05	0.51	0.74
THI	Correlation	-0.73	0.43	0.35
	P value	0.00	0.10	0.18
Litter pecking	Correlation	0.54	-0.58	0.03
	P value	0.03	0.02	0.92
Stretching	Correlation	-0.55	0.09	-0.14
	P value	0.03	0.74	0.62
Lying	Correlation	-0.58	-	0.06
	P value	0.02	-	0.84
Running	Correlation	-	-0.58	-0.36
	P value	-	0.02	0.17

\* Values in bold show statistically significant results ( $p \text{ value} < 0.05$ ). IL = luminosity. DBT – dry bulb temperature. RH = Relative humidity. Vair = air velocity.

Running was negatively correlated with temperature, air velocity, and THI (Table 3), and presented positive correlation with scratching the litter and negative correlation with stretching and lying, as expected, because running is an active behavior, opposite to lying and stretching. According to Salgado (2006), stretching occurs before lying, and Campos (2000) observed that broilers reduce their physical activity when there is no thermal comfort. The positive correlation between running and scratching shows that the broilers in the present experiment were able to express their natural behavior, as scratching is an inherent behavior of chickens (Weeks & Nicol, 2006). Scratching was more frequent in T2, whereas there was no difference among the other treatments (Figure 6). The rearing environment in T2 provided thermal comfort, allowing birds to express natural behaviors, such as scratching.

Lying was positively correlated with temperature and negatively correlated with humidity, and presented

positive correlation with eating and negative with running and scratching the litter (Table 3). Lying was more frequent in T1 than in the other treatments, which were not different from each other (Figure 6). According to Silva *et al.* (2006), lying indicates stress, because in hot environments, above the thermal neutral zone, broilers reduce their physical activity in order to produce less body heat, remaining lying most of the time (Rutz, 1994).

It should be mentioned that THI in T1 (Figure 2) was outside the optimal range, which would have explained this hypothesis; however, THI was similar between T3 and T1 (Figure 2), and the frequency of lying was lower (Figure 6). Therefore, the best explanation is the low luminosity level. According to Deaton *et al.* (1976) and Proudfoot & Sefton (1978), the physical activity of broilers reared in environments with low luminosity is reduced.

Lying was positively associated with eating, and negatively associated with running and scratching the litter, in agreement with Alvino *et al.* (2009), who found lower physical activity in broilers maintained in darker environments, and with Weeks & Nicol (2006), who reported that broilers reared confined in poultry houses reduce their litter-scratching behavior because there is high feed availability.

Drinking was positively correlated with luminosity (Table 3). Broiler present higher physical activity in light environments (Alvino *et al.*, 2009) and one of the ways broilers exchange heat is by increasing their water intake (Cordeiro, 2007). Drinking was less frequent in T2 (Figure 6), which temperature was lower, compared with T1 and T3. These results suggest that, although higher luminosity stimulated physical activity, the low temperature allowed better heat exchange, and therefore, there was less need to drink water.

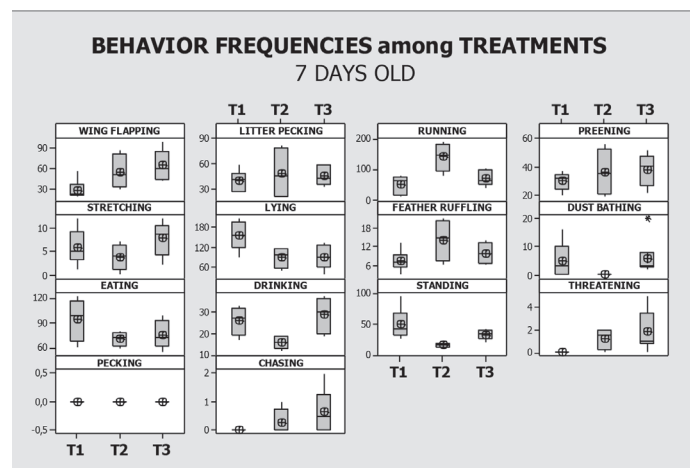


Figure 6 – Box plot of the behavior frequencies among treatments when broilers were seven days old.



## CONCLUSIONS

Luminosity, together with thermal environment, influenced the behavior of seven-day-old broilers. Therefore, in order to provide good welfare conditions, broilers should be reared in lighter environments, with higher luminosity than those found in the so-called dark houses. The present study showed that “blue houses” have the luminosity range and the thermal environment required to provide adequate welfare for seven-day-old broilers.

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