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Environmental and Physiological Variables During the Catching of Broilers

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ABSTRACT

The objective of this study was to determine the critical points of the operation of broiler catching for transport to the processing plant from animal and operational perspectives. During catching, chickens, environmental variables (temperature and relative humidity) were constantly monitored to determine the Enthalpy Comfort Index (IEC). Also, the physiological variable rectal temperature (RT) was monitored as an indicator of stress suffered by the birds during this handling procedure. Bird welfare were evaluated by analyzing their behavior. The bag method was effective to prevent the struggling of birds while being taken from the broiler house to the transport truck, reducing physical injuries and losses during catching.

INTRODUCTION

According to the Annual Report of Brazilian Poultry Association (UBABEF) published in 2014, Brazil is currently the third largest global broiler producer and occupies the largest exporter of chicken meat. Around 68.4% of the production is domestically consumed, and 31.6% is exported. The Brazilian poultry industry has always made heavy investments in technological improvements to increase production. Despite these investments, losses still occur. Some of these losses happen during the pre-slaughter stage, when several of the applied handling practices may be harmful because they compromise broiler welfare, survival, and carcass quality. According to Rocha *et al.* (2008), pre-slaughter handling affects broiler welfare, causing 90% of the injuries observed by the health inspection service.

Catching in one of the most critical stages of the pre-slaughter period because broilers are exposed to a high degree of stress and may suffer from bruises, scratches, and fractures, which result in carcass downgrading and even death of the birds. Therefore, care should be taken to minimize losses during this phase, particularly to the environmental conditions. The temperature of the internal environment of poultry houses is essential for the success of catching in regions with predominance of high temperatures all year long (Lavor *et al.*, 2008). This stresses the need for paying greater attention to factors related to poultry homeostasis during catching in order to prevent performance losses and poor bird welfare. This study aimed at evaluating and determining broiler stress during catching.

MATERIAL AND METHODS

The experiment was conducted by the NEAMBE (Animal Welfare and Agricultural Environment Study Group – UFC) in October, 2011, on a broiler farm belonging to a broiler company. According to the Köppen classification, the climate of the experimental area is Aw', with 26ºC average temperature. The geographical coordinates of the evaluated broiler house are latitude 4 ° 13 '20' S, longitude 38 ° 12 '1' 'W. The catching of broilers was evaluated in one broiler house with the following dimensions: 12 m width, 100 m length, 2.30 m ceiling height, and 1.00 m eaves, with a capacity of 9,000 broilers. The roof was covered with ceramic tiles, no dropped ceiling, the sides were open and covered with 40-cm high plastic curtains. The housed was equipped with ventilation fans and foggers, which were turned manually on at the hottest hours of the day, bell drinkers, and tube feeders. No pen divisions were used. The litter consisted of sand and wood shavings. Broilers were Ross®308 and six weeks old at the time of catching. The catching operation was evaluated in the morning (08:00 to 11:59) and in the afternoon (12:00 to 15:59).

Environmental variables

Temperature (°C) and relative humidity (%) inside and outside the broiler house were monitored every minute by data loggers installed at inside the house and outside the broiler house. The equipment was set 0.5 m from ground level at the center of the broiler house and slightly higher than the broilers' height in order to obtain representative readings of the conditions to which the birds were submitted.

Thermal comfort index

The thermal comfort index is a measure of the enthalpy expressed as the amount of thermal energy in kJ contained in 1kg dry air. Thermal comfort index is used to quantify and classify birds' thermal discomfort, which may affect their physiological responses and live performance (Damasceno *et al.*, 2010). The applied enthalpy equation was that proposed by Rodrigues *et al.* (2010), which includes temperature (ºC), relative humidity (%) and local barometric pressure (mmHg) values. The Enthalpy Table, developed by Queiroz *et al.* (2012), was used for the practical evaluation of the Enthalpy Comfort Index (ECI) of six-week-old broilers reared in regions located at sea level.

Rectal temperature of broilers

The rectal temperature (RT, in °C) was the main physiological variable evaluated during the experiment, aiming at determining the thermal comfort physiological response of broilers inside the broiler house before, during, and after catching. In general, innermost body regions have more constant temperature, whereas surface regions present more variable temperature, as they are more influenced by the external environment (Silva, 2000). Rectal temperature was determined by inserting a digital thermometer into the cloaca of seven broilers for one minute or until temperature stabilization before, during, and after catching in the morning and in the afternoon.

Statistical analysis

This study was designed to be a quantitative, experimental, and cross-time (Appolinário, 2010). According to this author, a cross-time study is made with only a single collection of data, with different groups of subjects. This number of broilers analyzed during each phase of the experiment allowed for the normality of the sample distribution, which was assessed for skewness and kurtosis, according to Hines *et al.* (2006).

In order to determine if there were significant differences in rectal temperature, before, during, and after catching, data were compared by the test ofusing the Tukey test, using the software MINITAB® 15.0.

Behavioral parameters

The behavior of broilers during the catching procedure was continuously recorded using a digital camera for later analysis of their behavior during the catching. The videos were analyzed to observe the reaction of the birds to catching and to describe their behaviors. Although the birds move constantly during catching, the videos allowed the observation and interpretation of behavior.

Bag method – description of catching

The farm evaluated in this study does not adopt the procedure of fasting before the catching. Birds are not fasted because they are sold live for small processing plants, where birds are then fasted during lairage. One hour before catching started, the rectal temperature of seven randomly selected broilers randomly selected was measured to determine their temperature under normal conditions. During catching, foggers were turned off and the fans remained operating to minimize the discomfort caused by the dust produced inside the broiler house while birds and people moved. Broilers inside catching circles were caught in twos by the back (Japanese method) and placed in bags that carried seven birds each.

During catching, birds were transported from inside the broiler house to the outside inside bags made of yellow canvas (50-cm long, 30-cm wide, with top opening of a maximum of 60 cm). Bags started to be used on the farm to prevent catchers from excessively handling the birds, thereby preventing carcass damage and to avoid bringing transport crates inside the broiler house, because they may be a source of contamination of broiler litter.

While inside the bags, broilers were weighed and then placed into the transport crates. The bag containing broilers was weighed to determine average broiler body weight. The same amount of birds placed into the bags was placed into the crates. A crate may carry six or seven birds, depending on broiler age and weight; the number is reduced as broiler age and weight increase. In this experiment, seven birds were transported by bag. The time of permanence of broilers inside the bags varied according to the distance between the catching circle and the place where the truck was parked. Rectal temperature was also measured when the broilers were inside the bags, and was considered the rectal temperature during catching. The birds were then placed inside a transport crate, where they remained for 20-30 minutes. When the catching was nearly finished, the rectal temperature of the broilers inside the crate was measured again, and was considered as the rectal temperature after catching.

RESULTS AND DISCUSSION

Catching time varied according to the amount of birds to be caught per shift. In the morning, catching lasted 01h05min and 01h10min in the afternoon. Average body weight during catching was 3.371kg in the morning and 3.257kg in the afternoon.

Environmental variables

According to Macari & Furlan (2001), the optimal temperature range for six-week-old broilers is between 21-24ºC. The temperature of 24ºC is considered as the upper limit of Thermal Stress (UL), and the temperature of 21ºC as the lower limit of Thermal Stress (LL). During both shifts evaluated, the environmental temperature was higher than 24ºC (UL), which may affect broiler thermal comfort (Figure 1). Higher temperatures were observed in the afternoon, as expected.

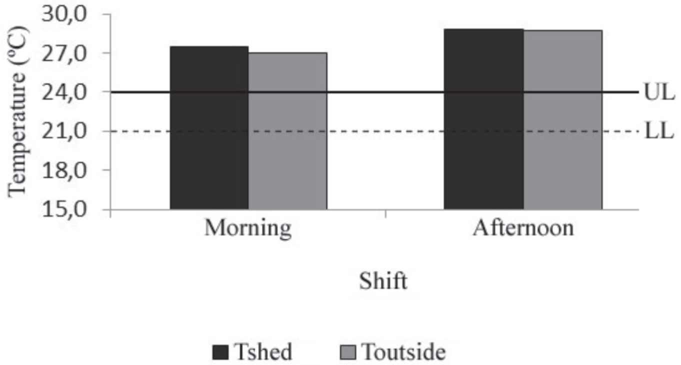

Figure 1 – Mean values of the environmental variable in temperature inside and outside the broiler house evaluated in two shifts, morning and afternoon. (UL - Upper Limit of thermal stress and LL - Lower Limit heat stress).

During the afternoon, the temperature inside the broiler house was 28.8ºC and outside was 28.7ºC. In the morning, values were somewhat lower, 27.5ºC inside, and 27.0ºC outside the broiler house. These results are consistent with those reported by Barbosa Filho (2008), who found higher temperatures inside and outside of broiler houses in the afternoon. That author also suggested that the pre-slaughter handling during the afternoon shift more harmful as birds may suffer from heat stress.

According to Macari & Furlan (2001), optimal relative humidity for broiler production is around 60%, and values below 40% and above 80% are critical. Relative humidity of 75% is considered as the upper relative humidity limit (UL) and 60% as the lower relative humidity limit (LL). The relative humidity values measured during both shifts in the present experiment were higher than the optimal value recommended (Figure 2).

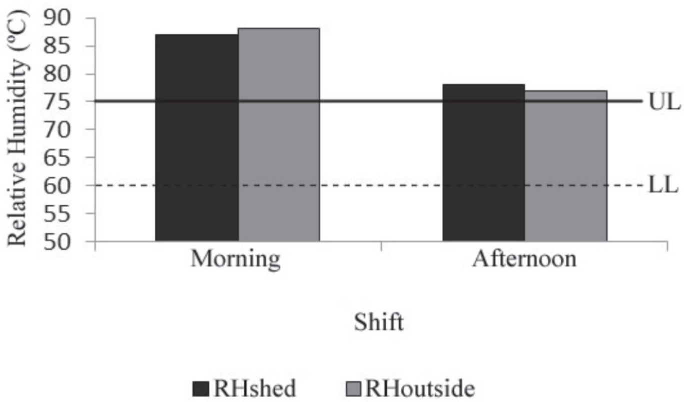

Figure 2 – Mean values of the environmental variable relative humidity inside and outside the broiler house evaluated in two shifts, morning and afternoon. (UL - Upper Limit of thermal stress and LL - Lower Limit heat stress).

In the morning, relative humidity was 87% inside and 88% outside the broiler house. In the afternoon, relative humidity was 78% inside and 77% outside the broiler house. Relative humidity in the morning was higher due the occurrence of rainfall at the time of data collection. Barbosa Filho (2008) recorded relative humidity values below 80% inside the broiler house in the morning, which was also associated with the occurrence of rainfall at the time of data collection. The increase in relative humidity may affect the thermal comfort of broilers, because it impairs the evaporative heat loss. The greater the relative humidity, the more difficulty broilers have to remove the internal heat through the airways, leading to increased respiratory rate (Oliveira *et al.*, 2006).

Thermal comfort index

Using the recorded temperature and relative humidity data, thermal condition was classified according to the Enthalpy Comfort Index (ECI) for six-week-old broilers. The ECI includes four thermal comfort and stress ranges: the comfort zone is between 37.4 – 52.1 kJ/kg dry air, the warning zone is between 52.2 – 63.0 kJ/kg dry air, the critical zone is between 63.1 – 72.6 kJ/kg dry air, and the lethal zone is above 72.7 kJ/kg dry air (Queiroz *et al.*, 2012).

During catching, the ECI was calculated for the inside and the outside of the broiler house every ten minutes. During the morning catching, ECI values were higher than 78 kJ/kg dry air both inside and outside the broiler house. These values are in the lethal zone, a condition that causes extreme stress for the birds. Under this condition, broilers may develop polypnea and eventually die (Medeiros *et al.*, 2005).

In the afternoon, average ECI (78 kJ/kg dry air) was lower than in the morning, but still in the lethal zone. This value indicates that the thermal conditions inside the broiler house were very poor, because the combination of high temperature and high relative humidity can cause broilers to die. When submitted to thermal stress, depending on the magnitude and duration, broilers present high prostration and mortality rates (Moura, 2001). Silva *et al.* (2007) observed that the duration of exposure to high temperature and high relative humidity significantly influences broiler rectal temperature (RT) and respiratory rate. According to those authors, broilers submitted to high temperature and high relative humidity tended to present higher RT values as exposure time increased.

Rectal temperature of broilers

According to Macari & Furlan (2001), 41.1ºC is the lower rectal temperature limit of heat stress and when this value is exceeded, broilers are under heat stress, suffering physiological changes to try to maintain optimal body temperature. These physiological changes negatively affect live performance. Broilers with rectal temperature above 46.3ºC usually die (Silva *et al.*, 2007). Average RT recorded during catching in the morning and afternoon shifts was 42.9ºC and 41.2ºC, respectively, exceeding the limit of 41.1ºC, evidencing heat stress. Barbosa Filho (2008) obtained, in the summer, mean RT values of 41.6ºC and 42.6ºC during catching in the morning and in the afternoon, respectively. RT values of broilers obtained during the catching in the present study were close to those mentioned by that author.

Statistical evaluation of rectal temperature of broilers

As shown in Table 1, kurtosis and symmetry coefficients of RT before, during, and after catching, in both shifts, were within the range -2 and 2, fitting to a normal distribution curve, according to Hines *et al.* (2006).

Table 1 - Descriptive statistics of rectal temperature (RT) during catching in the morning and in the afternoon.

Variables	Rectal temperature (ºC)					
	Before catching		During catching		After catching	
	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon
Observations	7	7	7	7	7	7
Mean (ºC)	40.6	40.5	42.9	41.2	43.1	41.9
SD (ºC)	0.287	0.141	0.535	0.195	0.503	0.439
Variance	0.082	0.0200	0.286	0.0381	0.253	0.193
CV (%)	0.71	0.35	1.25	0.47	1.17	1.05
Range (ºC)	0.800	0.400	1.700	0.600	1.600	1.200
Skewness	-0.37	0.00	0.59	0.28	-0.36	1.31
Kurtosis	-0.32	-1.20	1.34	0.04	0.90	1.59

SD – standard deviation and CV – coefficient of variation.

Table 2 presents the results of the F test, which show that RT means were different at 5% significance level between the two shifts.

Table 2 - Analysis of variance in rectal temperature (RT) during the morning and afternoon.

Variables	DF	SS	MS	F	Test F P
			Morning		
Factor	2	27.570	13.785	66.55	0.000
Error	18	3.729	0.207		
Total	20	31.298			
			Afternoon		
Factor	2	6.4467	3.2233	38.53	0.000
Error	18	1.5057	0.0837		
Total	20	7.9524			

DF – degrees of freedom, SS – sum of squares and MS – mean square.

Means were then compared by the test of Tukey, and Table 3 shows recta temperature results relative to catching time and shift.

Table 3 – Comparison of rectal temperature (RT) relative to catching time and shift.

RT (°C)	Morning	Afternoon
Before catching	40.6 ± 0.287 A	40.5 ± 0.141 A
During catching	42.9 ± 0.535 B	41.2 ± 0.195 B
After catching	43.6 ± 0.503 B	41.9 ± 0.439 C

Means followed by equal letters in the same column are not statistically different by Tukey's test (p<0.05%).

Mean RT values increased during the experimental period. Similar results were found by Silva *et al.* (2007), who obtained a mean RT of 40.3°C in broilers before heat stress, and this value increased as heat stress conditions became more severe. As expected, the lowest mean RT was obtained before catching, and higher RT means during and after catching. Rectal temperature values before catching did not exceed 41.1°C, which is the lower heat stress limit for broilers. This demonstrates that birds were not under heat stress before catching started.

The mean RT values obtained during and after catching in the morning shift were not statistically different, whereas mean RT values measured at the three different catching times in the afternoon were different from each other. Mean RT values during and after the catching in both shifts exceeded 41.1°C, indicating that broilers increase body temperature when exposed to adverse and stressful situations. These results agree with those of Garcia *et al.* (2007), who verified a significant increase in broiler stress during the catching, as evaluated by the increase in RT.

In the two shifts, the RT of broilers reached higher values after the catching, while inside the transport crates. As mentioned earlier, the rain probably caused the higher RT in the morning shift than in the afternoon. Then, due to high relative humidity during the morning, birds were under greater stress both during and after the catching. Therefore, the RT measured during those phases did not differ statistically. Barbosa Filho (2008) recorded during transport crate loading in the summer, RT values of 41.8°C and 42.7°C in the morning and in the afternoon, respectively. Placing broilers inside the crates is a stressful procedure due to the confinement and mixture with unknown birds, and causes some physiological changes indicative of stress (Knowles & Broom, 1990).

Behavioral parameters

When catching started, catching crews entered in the broiler house, causing broilers to stir and disperse until the end of catching. Some behaviors were quite evident and widespread, such as vocalization, escape attempts and panting. Paranhos da Costa (2006) reported that environmental factors may influence the responsiveness of birds. Some of these factors are aggressive handling and the lack of habituation of broilers to humans, which may increase the intensity of their reactions. That author also observed that panic reactions are more common during critical moments of handling, such as during catching. On this farm, the transport crates were not used to form the catching circles to prevent contamination of broiler litter by the crate because they are used in the external environment of the farm. In this case, a hinged-metal fence was used to trap the birds.

Inside the circle, birds tended to cluster on the corners and sometimes began to pile up, climb over each other in an attempt to escape. This crowding is detrimental to broiler welfare and carcass quality because birds may get hurt and, when climbing on each other, their nails may cause skin lesions. While being caught, some broilers struggled, but most could not do it because their wings were held and immobilized, because they were caught by the back. After being placed inside the bags, birds remained quiet and moved little. The low light inside the bag may have contributed to calm the birds during catching. Jones *et al.* (1998) analyzed strategies to reduce panic in birds, and one alternative was to cover their heads with a hood to reduce visibility. Those authors found that the use of hood virtually eliminated struggling. According to Gregory & Bell (1987), there are strong evidences that reducing light intensity calms down the birds.

In addition to reduced light intensity, the other factor that may have contributed for the little movement of birds inside the bags was the reduced space, which did not allow the birds to move. Jones *et al.* (1998) observed reduced struggling of broilers shackled in the processing line when a heavy curtain was suspended from the overhead conveyor. The authors concluded that the heavy curtain limited the movement of birds or that they remained motionless due to the continuous tactile stimulus from the curtain. In the present study, bags allowed continuous tactile stimulus, representing a physical obstacle that prevented wing flapping and vision, and were very effective in minimizing and reducing the harmful effects of panic reactions. This immobilization during catching probably helped reducing carcass injuries and improved broiler welfare, and it is one of the reasons why this method is used on this farm. Improving the welfare of poultry is a goal of the poultry industry, since there is a growing demand for animal products from systems that treat animals humanely (Rocha *et al.*, 2008).

Upon being placed in the transport crates, broilers vocalized and flapped wings trying to escape. Some of the birds hit the crates, which caused carcass damages, especially to wings that were more exposed. After some time inside the crates, birds became quieter, static, because no movement was possible inside the crates, and all remained panting. According to Barbosa Filho (2008), during loading and transport, birds may be exposed to low ventilation and high temperature, and the accumulation of water vapor resulting from panting compromises the efficiency of evaporative heat loss and effectively increases the thermal load on birds. Therefore, loading and transport also exert a strong influence on the welfare of broilers.

CONCLUSIONS

1. The time when broilers were more susceptible to heat stress was during and after catching, as demonstrated by the increase in broiler rectal temperature.
2. The morning shift proved to be the least adequate for catching, probably due to rainfall, resulting in high relative humidity values.
3. The bag method was effective to prevent the struggling of birds while being taken from the broiler house to the transport truck, and this will certainly aid reducing physical injuries and losses during catching.
4. Broilers should not remain too long inside the bags, since there is a risk of worsening heat stress and of death by asphyxia.

The experiment was approved by the Ethics Committee on Animal Research (CEPA) of the Federal University of Ceará (UFC), # 70/2012, and complies with the law and the Ethical Principles published by the Brazilian College of Animal Experimentation (COBEA).

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