XVII[th] World Congress of the International Commission of Agricultural and Biosystems Engineering (CIGR)

Hosted by the Canadian Society for Bioengineering (CSBE/SCGAB)
Québec City, Canada June 13-17, 2010

THERMAL ENVIRONMENT INSIDE BROILER HOUSING USING DISTINCT LATERAL MEMBRANE STRUCTURE

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CSBE100841 – Presented at Section II: Farm Buildings, Equipment, Structures and Livestock Environment Conference

ABSTRACT Broiler performance decreases when the birds are exposed to heat stress. Minimal construction is used in Brazilian broiler production, and it relies mostly on lateral curtain (membrane structure) use. This research had the objective to evaluate the broilers' surface temperature reared inside two controlled environment houses using two distinct types of membrane structure (G1 and G2). Trial took place in São Paulo state in Northeastern Brazil and data were collected during four weeks. Membrane G1; external and internal color is blue, non-laminated polypropylene with an emissivity of 0.97. Membrane G2; external color is white and internal color is blue, with plastic-coated polypropylene, and an emissivity of 0.87. Surface temperatures were registered using a thermal camera and the images were processed extracting the punctual values of temperature in both birds and membranes. Statistical analysis was done using two ways ANOVA (house and birds age) and the averages were compared using Tukey test at a significance level of 95%. Membrane temperatures were significantly different ($p<0.05$) and the higher averages were found in house G2. The G1 house with the external white membrane showed the lowest temperatures inside, while the G2 house presented the ambient temperature closest to the outside environment. Both birds surface temperature and membrane temperatures varied significantly ($p<0.05$) with the age of the broilers. The membrane using reflective color and plastic coated material provided more suitable ambient temperatures for rearing broilers under tropical conditions.

Keywords: thermal comfort, constructive membrane, thermography.

1. INTRODUCTION

Large economical losses occur in Brazil during broiler production due to heat stress, reducing the birds' performance and increasing their mortality (Yahav et al., 2001). Broiler housing has been changing in the country, and producers are largely moving to the use of curtains in all sides of the housing. The thermal environment of these buildings is different from those using conventional materials such as bricks in the end walls, as these membranes have a distinct way of exchanging heat with the outside environment. Thermal environment of membrane structures have been studied by He and Hoyano (2009) using infrared images obtained using a thermographic camera. The authors determined the influence of outside environment in the thermal profile inside and below the membrane structure. This research had the objective of analyzing ambient data and the surface temperature (ST) of broilers reared at two distinct housing conditions and using two distinct types of membrane structure as housing curtains.

2. MATERIALS AND METHODS

The research took place in two broiler houses distant 30m from each other (H_1 and H_2) and with similar structural characteristics and negative pressure ventilation, and membrane as curtains with characteristics listed in Table 1.

Table 1. Technical characteristics of the membranes used as curtains in the studied broiler houses.

	Membrane element 1 (house 1)	Membrane element 2 (house 2)
Color (ext. and int.)	blue	white
Material	polipropilen	polietilen
Density (g/m^2)	93	125
Width(μ/mm)	170/0.17	180/0.18
Emissivity	0.97	0.87

The houses were virtually divided in six sectors and air temperature (t, °C) and relative humidity (rh, %) were recorded using a data logger placed at 1m above the bedding. Data was recorded every 30m during four weeks of production (1 to 28 days). The internal environment of both houses was compared using images resultant from the software Surfer 8®. The air speed (as, m/s) was recorded simultaneously using a thermo hydro anemometer HTA®. Thermal images were captured using an infra red camera Testo® 880 and processed using the software Testo IRSoft®. Both infra red images were obtained placing the camera in perpendicular angle to the curtain, at a 2m distance in the six sectors of the houses. In order to analyze the images 100 points of surface temperature (st, °C) were selected in each membrane. Mean surface temperature was determined. The same infra red camera was used to register the surface temperature of the broilers. The infra red images of the birds were analyzed collecting the mean surface temperatures of the birds (Figure 1). Another analysis was done using the surface temperature of the areas with feathers (AWF) and the featherless areas (AF). Thirty distinct birds in each house were used in the study.

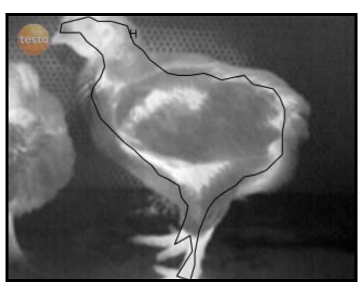


Figure 1. Image broiler area limited for collecting the mean surface temperature.

The statistical analysis was done using two ways ANOVA (house *vs* age) and mean data were compared using the Student t test. Significance was accepted for 95%. The software Minitab ® 15 was used for processing data and doing statistical analysis.

3. RESULTS AND DISCUSSION

House 1 presented lower mean air temperature and air speed than House 2, while the result of relative humidity was higher than in House 2 (Figure 2).

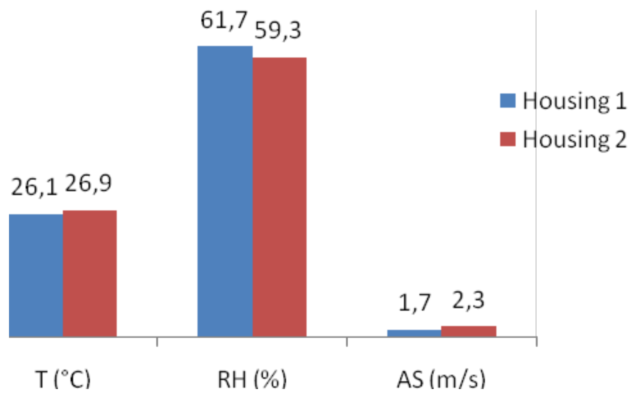


Figure 2. Mean air temperature (t), relative humidity (rh) and air speed (as) in the two studied houses using distinct membrane structures.

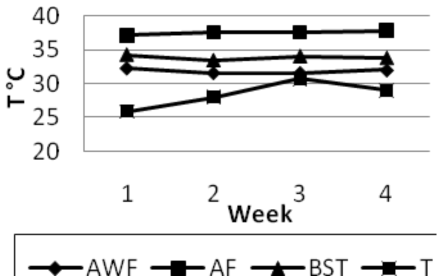
According to Tinôco (2001) thermal environment inside the houses are in compliance with Standards maintaining the mean daily temperature below 28 °C and the relative humidity within the recommended range of 50 to 70%. This means that the broiler were within the thermal comfort zone in both treatments. Air speed results were above the recommended by Medeiros et al. (2005), which is 1.5 m/s^{-1}; however, this recommendation applies well for younger birds and can be higher for older birds that benefit from the increase of air speed when close to the age of slaughter. Air speed was generally higher in House 2. Internal external surface temperature of House 2 was higher than House 1 ($p<0.05$; Table 2).

Table 2. Comparison between surface temperatures (st) of the lateral membranes in both sides (internal and external) of the broiler houses.

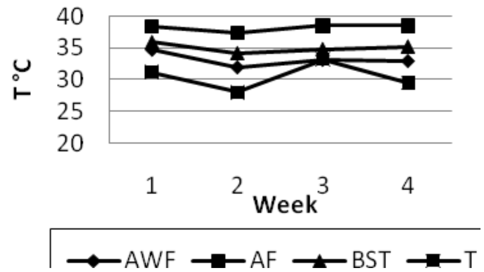
Broiler house	Week 1	2	3	4	average*
			ts internal membrane		
1	25.9 ± 1.9	26.9 ± 1.5	29.0 ± 2.3	30.4 ± 1.9	28.1 ± 2.6b
2	30.2 ± 1.5	26.2 ± 2.1	30.1 ± 2.0	31.7 ± 1.8	29.6 ± 2.8a
			ts external membrane		
1	29.5 ± 1.5	28.9 ± 1.5	34.3 ± 1.4	31.2 ± 0.8	31.0 ± 2.5b
2	30.5 ± 1.1	28.8 ± 0.9	36.2 ± 1.1	31.8 ± 1.3	31.9 ± 3.0a

* Student t test (95%).

The emissivity in membrane used in House 2 was smaller than the one in House 1, and the external and internal temperature was higher than in House 1 as well, resulting in higher heat transfer from outside to inside environment of House 2 when compared to House 1. As a consequence the air temperature inside House 2 was higher than House 1 (Figure 2).



Housing 1



Housing 2

Figure 3. Mean surface temperature (BST) of the areas covered with feathers (AWF), areas featherless (AF) and the air temperature (t) during the four weeks of growth.

No significant difference was found ($p>0.05$) between the surface temperatures of the birds (BST, AWF and AF) from 1 to 4 week of growth in both houses. According to Cangar et al. (2008) the smaller surface temperature is expected in older birds, as consequence of the large corporal size. However, this was not found in this research due to the fact that the air temperature (t) in the two enclosed environments did not differ ($p<0.05$) during growth (Figure 3).

4. CONCLUSION

Results showed that House 1 provides better enclosed environment for growing broiler under tropical conditions, probably due to the use of a membrane with thermal characteristics that avoid the external heat transfer to the inside environment.

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