Mapping the Thermal Comfort Index in Laying Hens Facilities

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Abstract

In the current poultry industry, which aims is to obtain high productivity in relatively small areas and short periods, the environmental conditions are of fundamental importance. The isolated determination of environmental variables as temperature and relative humidity does not permit correctly characterize the adequate environment within the facilities. The aim of this work was to monitor the thermal environment in laying housing and perform a complete mapping of the Temperature and Humidity Index (THI). The aviary is completely automated, having one 100,000 birds housed, at the peak egg production, in 8.400 cages distributed in four batteries of three hundred and fifty cages, each, in a vertical system of six floor levels. Eighteen sensors of air temperature and humidity were distributed, positioned between the batteries of cages in two equidistant uniform height levels (0.65 m and 2.75 m) over the entire facility. Temperature and Humidity Index (THI) was determined based on the temperature and relative humidity recorded. It was observed, during the night period, that the THI values remained within the comfort zone, according to published literature. The two height levels present very similar and uniform distribution, with the central zone with higher values than the extremities. For daytime, the lower level it was within the comfort range, with the east and central regions presenting the highest THI values. The top level in the central region was on alert for heat stress. The faces east and west reached the limit value of comfortable conditions for the animals.

KEYWORDS: Egg production, thermal distribution, temperature and humidity index.

1. 1. Introduction

The Brazilian posture poultry is one of the most important economic activities in the agricultural sector. In 2015 the Brazilian egg production totaled 39.5 billion units, this amount higher than 6.1% the production in the previous year, an increase was also seen in egg consumption in Brazil, from 182 units per capita in 2014 to 191.7 units in 2015 (ABPA, 2016). According Tinôco (2001) the bird needs environment-specific conditions, such as temperatures and relative humidity, atmospheric pressure, light and noise levels within certain ranges of tolerance. Each animal is capable of surviving until a certain adversity environmental limit, and this survival depends on several factors such as, for example, acclimation, age, sex and physiological condition.

However, in particular due to predominantly open aviaries type practiced in Brazil, the thermal environment remains the main factor that affects the productive performance. High temperatures and relative humidity inside the premises, especially in the summer and in the hottest hours of the day, may limit the productivity and welfare of birds, affecting the final performance of the lot and compromising the economic aspects of the activity (Carcalho, 2012).

Birds have different requirements according to age: in growing period the heat requirement is higher; already in the production period is observed an inverse correlation between temperature and productivity. High temperatures can cause decrease in feed intake, with reduction in production, egg mass and damage in shell quality (Albuquerque, 2004; Vitorasso e Pereira, 2009; Pereira et al., 2010; Xin et al., 2011, Hussen, 2011; Kilik e Simsek, 2013).

There are certain environmental thermal ranges in the bird energy expenditure for homeothermy maintenance is minimal, and thus productive performance is maximum. These thermal ranges, are known as ambient thermal comfort ranges, and very important to be maintained during the period in which the bird is housed in aviary (Baêta & Souza, 2010).

Thus, the map generation and analysis of environmental variables can permit better understanding of the thermal environment to increased microclimate management efficiency and overall activity performance to reducing mortality and improving the animal welfare. The aim of this work was to monitor the thermal environment in laying housing and perform a complete mapping of the Temperature and Humidity Index (THI).

2. 2. Materials and Methods

The experiment was conducted in a commercial laying hens house located in the Minas Gerais State, Brazil. The aviary is designed in the "vertical system", with 134 m long, 12.5 m wide and 5 m in height, metal frame and corrugated sheets of galvanized steel with ridge vents. The facility is opened in North/South sides and enclosed by walls on the East/West sides, to make possible the natural ventilation. The aviary has an automatic system of supply and distribution of feed, and water supply made by nipple drinkers. The removal waste is mechanically performed by conveyor belts. The eggs collection and transport are also carried out by mechanized operations.

Were housed 100,000 birds, at the peak egg production, in 8.400 cages distributed in four batteries of three hundred and fifty cages, each, in a vertical system of six floor levels. Eighteen sensors of air temperature and humidity were distributed to characterize all internal ambient of laying hens house. These sensors were placed between battery cages, and uniformly equidistant along the facility in two height levels: 0.65 meters (level 1) and 2.75 meters (level 2). These levels are the heights of the first and last level cages (Figure 1).

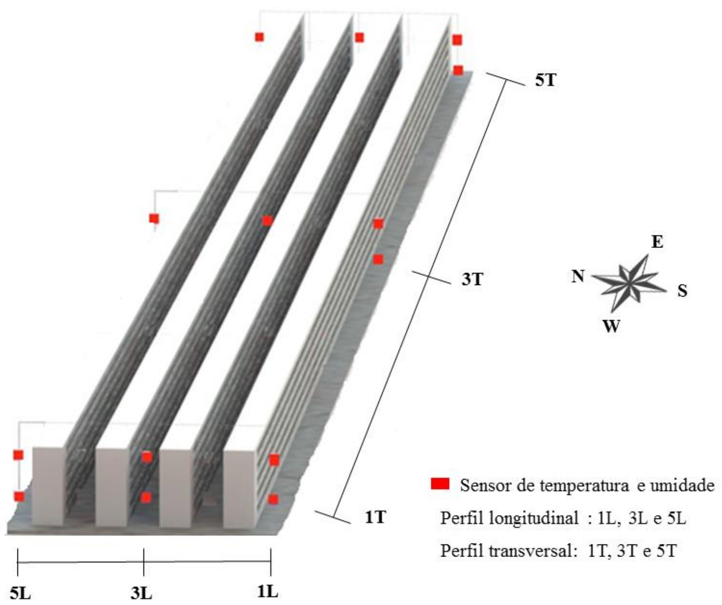

Figure 1 - Representation of the distribution of temperature and relative humidity sensors inside the aviary.

Data collection happened continuously (24 hours) each 1 minute, for eight days. Temperature and Humidity Index (THI) was determined based on the temperature and relative humidity recorded. Were generated THI maps of inside the facility, for daytime and nighttime periods during the experimental days.

3. 3. Results and Discussion

Notes that at night the THI values remained below the comfort range, according to the limits of Barbosa Filho (2004), both to the lower level (0.65 m) and to the higher level (2.75 m), the which have very similar and uniform distribution being the central aviary with above values found in the extremities (Figure 2).

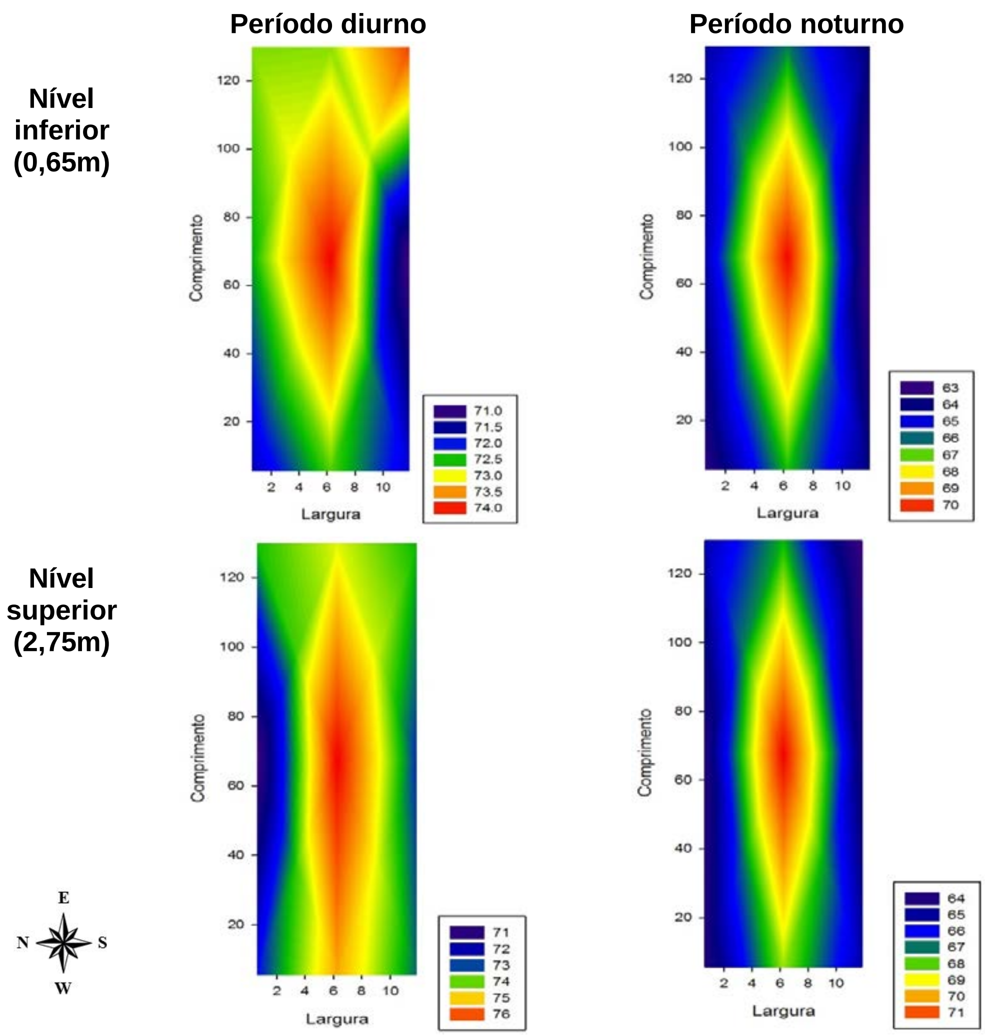

Figure 2 - THI maps for daytime and nighttime in level 1 and level 2.

For the daytime the lower level remains within the comfort range presenting the east side and the central region the largest THI values, very close to the limit, which is 75; already the top level with the central part in danger and face-east and west reaching the threshold value for a comfortable environment. Assigns the THI values higher to the higher level, mainly due to its proximity to the roof where the thermal radiation from the aviary coverage affects with higher proportions this region, as they distance coverage toward the floor of the aviary this effect will reduce.

Among the longitudinal profiles, the 3L profile (Figure 3) has the worst THI values being, according to Barbosa Filho classification (2004), during daytime in the danger range, so the batteries of the central installation corridor cages have the most critical situation in relation to heat stress. This fact can be explained by the presence of own battery cages, which act as barriers to natural ventilation and dissipation of heat produced by the birds in their metabolic activity. With the presence of these batteries the central region of the avian has worse thermal conditions, hence higher values of THI, since the installation side regions are exposed to the external environment, are influenced by the external temperature conditions, thus generally have lower rates. The 1L and 5L sections have unevenness in the distribution of THI along the shed length, but the values are within the limits of thermal comfort.

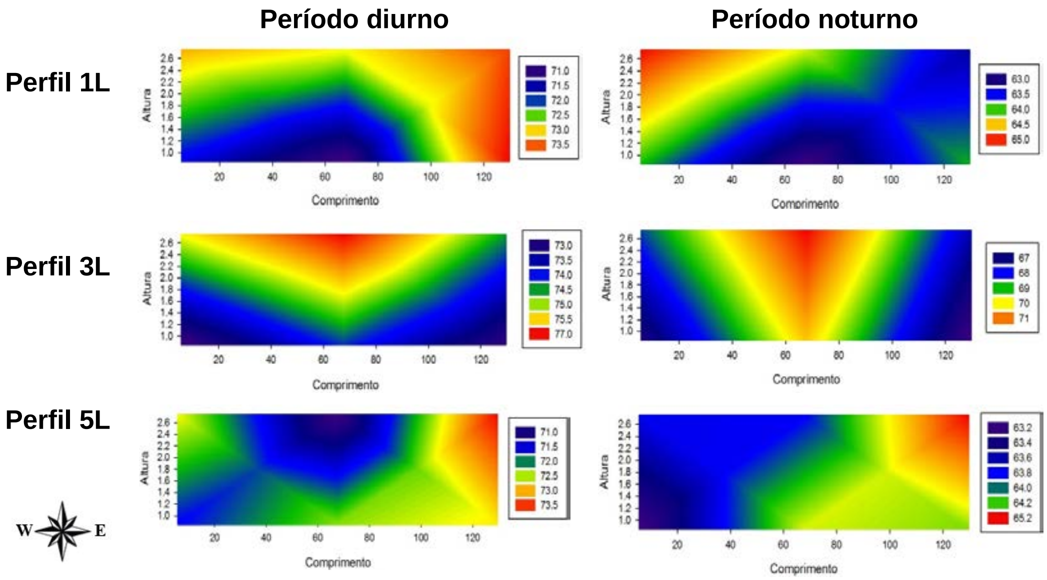

Figure 3 - THI maps for day and night, in longitudinal sections

In all cross-profiles (Figure 4), the average values of THI become smaller as they move away from the center of the installation, as expected, due to the air cooling by natural ventilation in the side edges of the shelter; however noted, the profile 5T, less reduction of THI in one of the lateral sides as a result of increased solar radiation in this region during the hottest hours of the day thus affecting the animals housed therein.

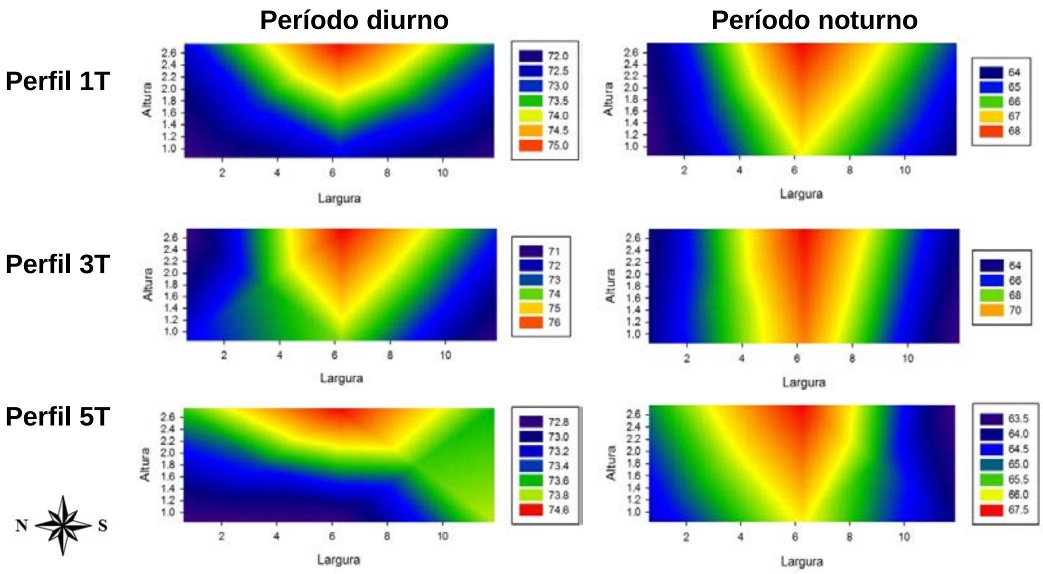

Figure 4 - THI maps for daytime and nighttime in cross sections.

Overall, considering all the internal aviary environment, THI for day period was an average value of 73, a figure higher than the nighttime, which was 65, which was expected, mainly due of higher temperatures during the day.

4. 4. Conclusions

The maps of Temperature and Humidity Index (THI) allowed diagnose the real conditions of thermal comfort of open facility for laying hen used in Brazil. It is concluded, therefore, on the need for care that should be taken when establishing managements of environmental conditioning systems.

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