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Correlation between egg quality parameters, housing thermal conditions and age of laying hens

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Abstract. High environmental temperatures cause a decrease in feed consumption by laying hens and, as a consequence, a reduction of productive performance and egg weight. The hens age is a factor influencing the albumen quality that tends to be more liquefied in older hens. Such variable is analysed by the determination of the Haugh Unit.
The correlations between the egg quality variables (egg weight and Haugh Unit), the thermo-hygrometric conditions in the facility and the age of laying hens were determined in the study and evaluated based on the Pearson correlation coefficient (r) and their significance at the 5% level. The microclimatic data and the eggs were collected in 20 points of poultry facility with birds of 43, 56, 69, 79 and 86 weeks of age, totalling 100 samples.
The results show significant correlations between egg weight and temperature (r = -0.238), egg weight and hens age (r = 0.310), Haugh Unit index and hens age (r = -0.256); a non-significant correlation between the quality parameters with the relative humidity of the air inside the barn. The egg weight had a weak negative correlation with the ambient temperature and a weak positive correlation with the hens age. Concerning the Haugh Unit, a weak negative correlation with the age of the animals was found. The weak or non-existent correlation of temperature with egg quality parameters can be due to the environmental conditions that remained in the range of thermal comfort for the animals during the trials.

Key words: environmental conditions, thermal comfort, poultry, laying hens, egg quality.

INTRODUCTION

Poultry facilities should be designed to guarantee suitable thermal conditions and satisfactory light intensity to the laying hens for quality egg production. In the design of facilities a particular attention has to be paid to reduce the risks of exposition of the birds to temperature and humidity peaks (Albino et al., 2014). Air temperature is the main factor that could cause losses in animal production on an industrial scale (Vitorasso & Pereira, 2009; Vilela et al., 2015).

The internal quality of the eggs is indirectly influenced by the microclimatic conditions, since, during heat stress, the birds tend to reduce the consumption of food and consequently the weight of the egg is negatively affected. The decrease of the egg weight is an effect of the reduction of the components, or at least some of the components: egg yolk, albumen, shell (Alves, 2007).

According to Ferreira (2010), the temperature inside the poultry house for adult birds may fluctuate between 15 °C and 28 °C, with air relative humidity varying between 40% and 80%. The ideal ambient temperature for egg production would be 21 °C to 26 °C. In the range of 26 °C to 29 °C a slight reduction in egg size can occur and between 29 °C and 32 °C a significant loss in egg size, affecting production, is remarked. Between 35 °C and 38 °C, bird prostration can occur and production can be severely affected (Alves, 2007).

Egg quality is determined in order to verify the differences in fresh egg production due to genetic characteristics, diets and age of laying hens, as well as the influence of the environmental factors to which laying hens are subjected (Alleoni & Antunes, 2001).

The age of the birds is a factor influencing the quality of the albumen and the weight of the eggs. In older birds the albumen tends to be more liquefied and the weight of the egg bigger. These two quality parameters are correlated by means of a mathematical expression called Haugh Unit, proposed by Haugh (1937). In general, higher the value of the Haugh Unit, better the quality of the egg is.

Many factors can affect the value of Haugh Unit, such as storage time, temperature, age of the bird, stress, nutrition (dietary protein and amino acid index, e.g. lysine, methionine, feed enzymes, grain type-protein source), health state, supplements (ascorbic acid, vitamin E), exposure to ammonia, moult induction, use of medications, etc. These factors impair albumen quality through distinct mechanisms, and consequently affect albumen height and thus the value of the Haugh Unit (Roberts, 2004).

Tůmová & Gous (2012) found that eggs of laying hens subjected to an environment with a temperature of 20 °C have greater weight and Haugh Unit value respect to eggs of hens subjected to an environment with a temperature of 28 °C.

In a poultry facility with pad cooling, Abbas et al. (2011) found differences in the air temperature and relative humidity at the extremities and at the centre of the building as well as differences in the egg weight. In the middle of the poultry shed, where the temperatures had smaller values respect to the sides, the eggs presented bigger weights.

The objective of the present work was to determine the correlation between the microclimatic conditions (air temperature and relative humidity) of poultry facilities and the age of the birds, with egg quality parameters (egg weight and Haugh Unit).

MATERIALS AND METHODS

The experiment was carried out in one of the largest commercial egg companies in Brazil, located in the municipality of Itanhandu - MG, south of Minas Gerais, 892 m above sea level, 22°17'45"S latitude and 44°56'5"W longitude. The region has a tropical climate with an average annual temperature of 19 °C, characterized as Cwb (wet temperate climate with dry winter and temperate summer) by Köppen climate classification.

The poultry facilities have similar structures, designed in a vertical system of cages, orientated in the East-West direction and distanced 15 m each other. The dimensions of the buildings are 134 m long, 12.5 m wide, 5 m high. The facilities are made of metal structure, galvanized steel roofing with lantern 1.2 m wide. Inside the facility four batteries of cages, each with 6 floors, are placed. The cages have the dimensions of 0.6 m x 0.5 m x 0.4 m, with 10 birds per cage and a surface per head of 300 cm² head^{-1}. Each facility has the capacity to accommodate up to 100,000 hens of the Hy-Line W-36 line age.

The feed is supplied by means of automatic feeders and water given by means of nipple drinkers. The collection and transport of eggs and the collection and removal of manure are mechanized through mats.

The experimental trials were carried out in one of the poultry facility of the farm. Within the facility, microclimatic data were collected for five days by temperature and relative humidity sensors, DHT-11 (Humidity & Temperature Sensor-DRobotics UK) for five days. The distribution of the sensors was performed in 45 points of the building in vertical and longitudinal directions. In the vertical direction the temperature and relative humidity sensors were installed in three levels of cages (Fig. 1) and, horizontally, in a fourth of the building (Fig. 2).

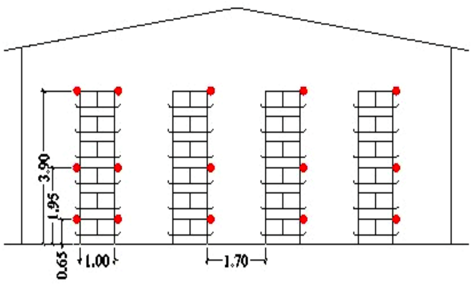

Figure 1. Vertical location of temperature and relative humidity sensors in the facility.

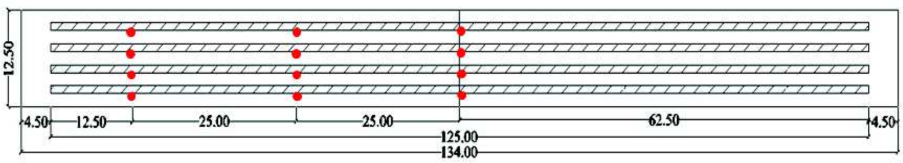

Figure 2. Longitudinal location of temperature and relative humidity sensors in the facility.

Each three sensors were coupled to a microcontroller, Arduino Mega 2560, for processing and storing the data of air temperature and relative humidity, captured by the sensors. In total 45 data collection points/sensors and 9 Arduino Mega 2560 microcontrollers were placed.

The eggs were collected at the collection points of temperature and relative humidity, in cages with laying hens at the ages of 43, 56, 69, 79 and 86 weeks. Egg weight (g), albumen height (mm) and Haugh Unit (UH) were the parameters evaluated to qualify the eggs.

The egg weight was obtained by weighing on a digital scale with an accuracy of 0.01 g. After weighing, the eggs were broken on a flat glass surface and with a tripod micrometre the height of the dense albumen was measured. The Haugh Unit was calculated by the mathematical expression that correlates the height of the dense albumen with the weight of the egg (Eq. 1).

$$HU = 100\log(H + 7.57 - 1.7W^{0.37}) \quad (1)$$

where: H – height of dense albumen (mm); W – egg weight (g).

The correlations between the egg quality variables (i.e., egg weight and HU), the thermal conditions and the age of the birds were evaluated based on the Pearson correlation coefficient (r) and their significance at the 5% level.

RESULTS AND DISCUSSION

The results show a significant correlation between: egg weight and temperature; egg weight and age; Haugh Unit and age; and non-significant correlation of quality parameters with the relative humidity of the air inside the facility (Table 1).

Table 1. Pearson correlation coefficients between the variables of egg quality, thermal environment of breeding and age of the birds (significance level 5%).

	Age	Temperature	Relative Humidity
Egg weight	0.310 ($P < 0.01$)	-0.238 ($P < 0.01$)	0.057 ($P > 0.05$)
Haugh Unit	-0.256 ($P < 0.01$)	0.009 ($P > 0.05$)	-0.067 ($P > 0.05$)

The egg weight had a weak negative correlation with the ambient temperature and a weak positive correlation with the age of the birds (Figs 3, 4), meaning that the egg weight variable tends to decrease with rising of temperature and to increase with the age of birds. In relation to the Haugh Unit a weak negative correlation with the age of the animals was found (Fig. 5).

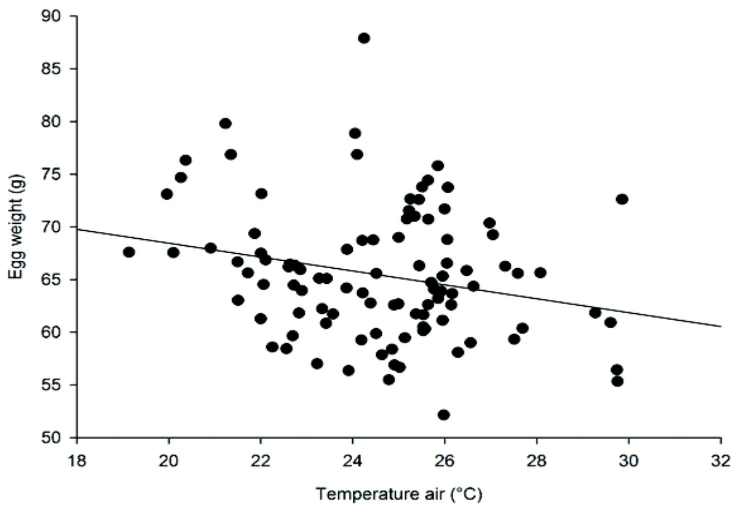

Figure 3. Correlation between air temperature and egg weight.

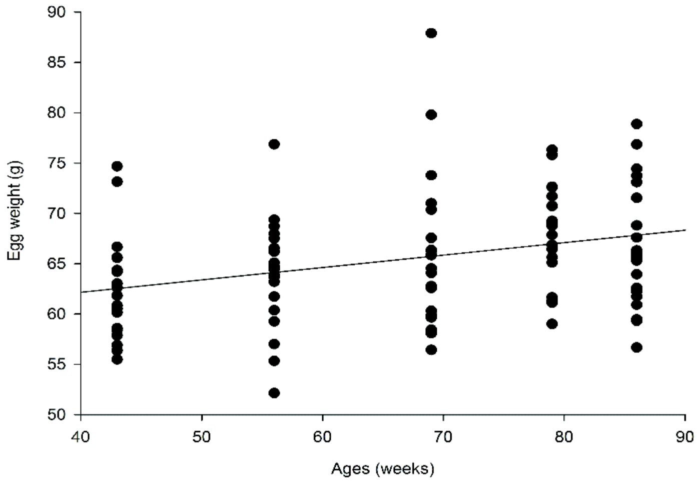

Figure 4. Correlation between age of laying hens and egg weight.

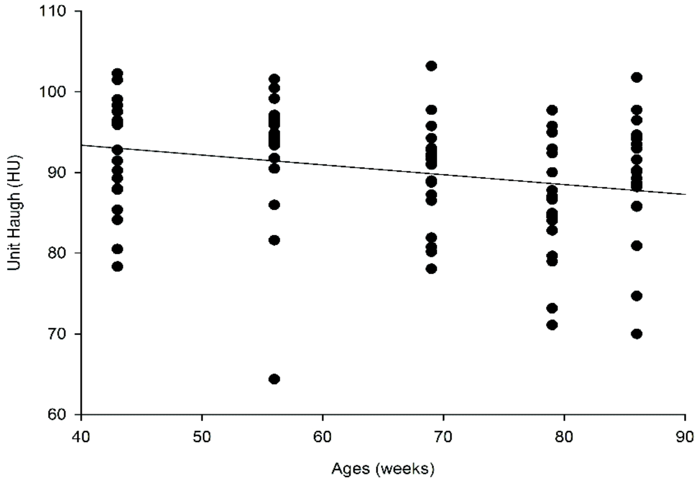

Figure 5. Correlation between Haugh Unit and age of laying hens.

Oliveira et al. (2011) found that laying hens between 23 and 42 weeks of age, kept on floor in a facility with artificial ventilation system and air temperature close to the comfort condition (27 °C), gave higher feed intake (110 $g^{-1}ave^{-1}day^{-1}$) and higher egg weight (58.1 g), compared to laying hens kept in conventional facilities without artificial ventilation (108 $g^{-1}ave^{-1}day^{-1}$ and 58.1 g, respectively).

Faria et al. (2001), analysing the egg quality of laying hens 21 weeks old in different thermal conditions during a period of nine weeks, concluded that the temperature affected the feed intake. The condition of constant heat stress presented lower feed consumption by hens and lower egg weight. Also Zavarize et al. (2011) remarked the influence of thermal conditions on feed intake and egg weight in laying hens.

Torki et al. (2014) found that thermal stress influenced the feed consumption and egg weight of laying hens in an open facility, while protein composition of the feed provided with an average temperature of 30 °C did not interfere on these parameters.

Carvalho et al. (2007) observed an increase in weight and a decrease in Haugh Unit value of eggs for hens with ages of 29, 60 and 69 weeks. The same result on egg quality was obtained by Alves et al. (2007). Menezes et al. (2012) also found a decrease of the Haugh Unit in laying hens eggs of 35, 40, 45 and 50 weeks of age.

CONCLUSIONS

The environmental conditions of poultry facility indirectly affect egg weight. The weak or non-existent correlation of the temperature with the parameters of quality of the egg found in this study can be attributed to favourable thermal conditions during the trials. The temperature of the environment in the period under study remained within the considered range of comfort for the laying hens during production (21 to 26 °C).

As further conclusion, it is possible to state that the age of the hens is a factor contributing directly to the increase in egg weight and to the decrease of the Haugh Unit.

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