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Relation between Sensible Temperature and Egg Quality in Environmentally Controlled Poultry House

Kadir ERENSOY[1,*], Ali ALTAN[2], Musa SARICA[1], Hakan BAYRAKTAR[2]

[1] *Ondokuz Mayıs University, Faculty of Agriculture, Department of Animal Science, Samsun, Turkey*
[2] *Ege University, Faculty of Agriculture, Department of Animal Science, İzmir, Turkey*
** kadir.erensoy@omu.edu.tr*

ABSTRACT

The studies has intensified in this area since the climatic environment of the poultry houses has been found to significantly affect the yield, performance and product quality of laying hens. The sensible temperature that is recently on agenda is a quite new concept for poultry farms. This study was conducted in an environmentally controlled house containing 8-tier cage system. The house was divided into 3 zones according to the distance to the ventilation fans. In each of the 3 zones and 1th, 4th and 8th cage tiers in these zones, 10 eggs was collected in each cage eyes and total 90 eggs were collected for a time. Measurements were replicated at 35-45-55th weeks flock age. Egg weight, shell ratio, albumen height, Haugh unit, yolk width, yolk height and yolk index were determined as quality parameters. The relations between sensible temperature, cage tier and egg quality were investigated in this study. The sensible temperatures were found significantly different between zones and cage levels in the house ($P<0.01$). The temperature difference between the zones was about 5.5 °C, while the temperature difference between the cage levels was about 4.5 °C. Eggs in different zones of the house only differed in yolk width and yolk height, while albumen height, Haugh unit, yolk width and yolk height were found to be different among the cage levels ($P<0.01$, $P<0.05$). It is considered that taking place the sensible temperature in the egg production houses may better reflect between the climatic environment and efficiency, performance, product quality.

Key words: Sensible temperature, Egg quality features, Controlled environment, Egg production.

INTRODUCTION

Egg production is an important sector of Turkey’s poultry livestock. The production which has increased by more than 50% in the last 10 years, caught 18 billion in 2016 and it is predicted that the growth will continue in the projections (TUIK, 2017). The number of laying farms, their size and type of houses are factors that are effective in increasing the production quantity. The sensitivity of hybrid laying hens to the environment necessitates climatic environmental control. This has accelerated the transition from curtain type poultry, where environmental control is not fully ensured to environmentally controlled poultry houses (Erensoy et al., 2015).

In order to be protected from the adverse effects of hot or cold environmental conditions, the temperature inside the poultry must be kept within the limits of “thermal comfort zone” 18-24 °C (Altan and Bayraktar, 2009). When the temperature of the poultry house goes above 25 °C, it causes temperature stress in the laying hens and extreme fluctuations in temperature with high humidity values have been reported to be much more dangerous (Sriharet et al., 2002; Simon, 2003).

Egg quality is affected by many factors such as genotype, age, lighting, ambient temperature, nutrition and stress. Environmental temperature affects water and water consumption, egg production and quality, and the level of utilization of feed in laying hens (Sterling et al., 2003). The effect of ambient temperature on egg yield and quality is not the same, the decline in yield at higher ambient temperatures is more pronounced than the decline in quality. The egg weight is reduced by 0.4% for every 1 °C increase between 23-27 °C, while it decreases by 0.8% every 1 °C above 27 °C (Altan, 2015). Also, Uğurlu et al. (2002) reported that increasing in the ambient temperature from 21.4 °C to 27.6 °C reduces feed consumption and egg weight. Ambient temperature and relative humidity are important parameters that determine the air quality. Air velocity has also been recognized and the sensible temperature has come to the agenda in recent years. The optimal humidity should be within the range of %60-70 in the house (Balnave, 2004). There was no decrease in feed consumption and live weight gain when the in-house relative humidity increased from 65% to 95% at 24 ° C, however feed consumption, live weight and egg weight were adversely affected when the ambient temperature was increased to 30 ° C under the same relative humidity conditions (Ketelaars, 2005). The average egg weight and Haugh unit increased when the air velocity was increased from 0 m/s to 1.52 m/s (Joseph et al., 2015). There are numbers of studies examining the effect of different cage tiers on egg yield and quality (Nazlıgül et al., 1995; Uğurlu et al., 2002; Awoniyi et al., 2003; Yıldız et al., 2006).

In this study, the relationship between the sensible temperature values and the egg quality parameters were investigated in different zones and cage tiers of the poultry house. Unlike previous studies, it was aimed to reveal the relationship between the egg quality features and sensible temperature rather than dry thermometer temperature.

MATERIAL AND METHOD

The experiment was carried out in an environmentally controlled commercial egg production house, 13x80 meters, constructed to long axis in north-south direction. The height of the roof is 6 m. The walls consist of 15 cm thick concrete blocks. The house is covered with a white sandwich panel and has a double inclined insulated roof and has an 8-tiers, 4-block cage system with a total capacity of 70 000 laying hens. Lohmann Brown genotype was used as animal material. The house where the experiment was carried out is located in Kemalpasa district of İzmir province where district has an average temperature of 7 °C in winter and 28 °C in summer.

The feeding system consists of grooved type feeders in each cage-tiers. The water system consists of a nipple water system with 2 nipples in each cage. The egg collection system consists of cloth belts in front of the cage on each tiers and moving conveyor belts positioned perpendicular to these belts. Tunnel ventilation fans are used which have high suction power which is operated by electricity. There are 24 tunnel fans located on the short side of the house to benefit from tunnel ventilation in summer. Pad cooling system is made of cellulosic material, which is an evaporative cooling element used to minimize the negative effects of summer heat on laying hens. The cooling pads are placed on the short and 2 long walls of the house. The lighting system consists of a compact fluorescent-type lighting element with 11 watts giving white light and a total saving of 160 units and is positioned on the 8th tier of the cage systems.

Data loggers with the continuous measurement feature of the Thermo Chron brand DS 1921 G#F50 is used for temperature and relative humidity measurements. Data logger is a temperature and humidity measuring device with the ability to measure at any time between -40 °C and +80 °C with ± 0.5 ° C temperature accuracy. Statistical analysis of the data obtained as a result of the measurements was performed using the SPSS 21.0 statistical program.

The inside of the poultry house is divided to 3 zones as head, middle and last. Temperatures were measured in the 1^{st}, 4^{th} and 8^{th} tiers in each area, and humidity meters are placed in the 4th floors at the head and the end of the house (last). At the same time, the air velocity measurements were determined manually with the Testo brand anemometer 3 times a day at the determined area and cage tiers. Temperature and humidity measurement devices recorded data in every 15 minutes. The collected data was transferred to the computer at the end of the day. Temperature, humidity and air velocity values in the poultry house were used together to determine the temperature values observed on index 1 determined by Barnwell (1997).

$$\textit{Sensible temperature} = 0{,}77531+0{,}71136Dbt+0{,}13181Rh-3{,}6814Av \qquad (1)$$

Dbt=Dry bulb temperature (°C)
Rh=Relative humidity (%)
Av=Air velocity (m/s)

The feeders were placed in the 3 zones in the poultry house and 2 caged poultry houses identified in each of these tiers were fed as ad libitum. Before the beginning of the measurement, feed were placed by pre-weighing, and after the measurement net feed consumption was determined by back-weighing. According to the animal numbers found in a cage eye, the consumption of feed is calculated for per animal. Eggs were collected every morning at 9:00 am in 3 zones in the poultry house and 2 cages determined in each of 1th, 4th, 8th tiers. In each of the 3 zones in the poultry house and in different times from the caged eyes determined in the 1th, 4th and 8th cage tiers in these regions, 10 eggs were collected from each cage eyes and total 90 eggs were collected for a time. Measurements were replicated at 35-45-55th weeks flock age. The eggs were kept at + 4 ° C for 24 hours and then egg quality traits were determined. Egg weight, shell ratio, albumen height, Haugh Unit and yolk diameter, height and index parameters were determined (Altan, 2015) and quality analysis were conducted by method described by Akbas et al. (1995).

RESULTS AND DISCUSSION

Sensible temperature, egg weight, shell ratio, albumen height, HU and yolk parameters were investigated in this study and means are given on Table 1. The difference between mean temperature of zones and cage-tiers were significantly different (P<0.01). While the highest sensible temperature value has observed in last zone (23.8 °C), it is followed by the middle and head zones respectively (21.8 °C, 18.4 °C). Also 8th cage-tiers are hotter than 4th and 1st tiers respectively (23.4 °C, 21.8 °C, 18.8 °C). It is seen that the temperature range is in the thermal comfort zone (18-24 °C) of the change intervals. The optimum range of sensible temperature values did not significantly affected egg weight and shell ratios in different zones and cage tiers (P>0.05).

Table 1. Sensible temperature and some egg quality features

Point of measurements		Sensible temperature (°C)	Egg weight (g)	Shell ratio (%)	Albumen height (mm)	Haugh Unit	Yolk diameter (mm)	Yolk height (mm)	Yolk index (%)
Zones	Head	18.4^{c}	64.8	9.57	6.52	77.7	41.3^{a}	19.0^{ab}	45.9
	Middle	21.8^{b}	65.3	9.58	6.52	77.5	40.8^{ab}	19.1^{a}	46.8
	Last	23.8^{a}	63.9	9.61	5.98	73.5	40.6^{b}	18.7^{b}	46.0
P values		**<0.01**	0.251	0.979	0.068	0.091	**<0.05**	**0.05**	0.087
Cage tiers	1th	18.8^{c}	65.3	9.80	6.67^{a}	78.5^{a}	41.5^{a}	19.1^{a}	46.1
	4th	21.8^{b}	64.8	9.51	6.47^{a}	77.3^{a}	40.6^{b}	19.0^{a}	46.8
	8th	23.4^{a}	63.9	9.45	5.88^{b}	73.0^{b}	40.6^{b}	18.6^{b}	45.7
P values		**<0.01**	0.267	0.139	**<0.01**	**<0.05**	**<0.01**	**<0.01**	0.085
SEM		0.04	0.62	0.13	0.19	1.49	0.22	0.13	0.30
Zones x Cage tiers		**0.000**	**0.029**	0.359	0.468	0.564	0.771	0.082	**0.026**

Differences in superscript letters within columns represent significant differences between groups.
SEM: Standart error of the mean.

Some studies have shown that there is a negative relationship between temperature and egg weight, Mashaly et al. (2004) report that the weights of the eggs will decrease as the temperature increases in the house. However, egg weight was not significantly affected by environmental temperature both in zones and on cage tiers in our study. Also, egg shell ratio was not change significantly ($P>0.05$). Usayran et al. (2001) reported that there is a negative relationship between temperature and shell quality, whereas the change in temperature does not affect the shell ratio in our study. While the albumin height didn't change between the different zones of the house ($P>0.05$), the variation was found significant ($P<0.01$) and the lowest at the 8^{th} tier in the cage tiers. In addition, it appears that the height of the albumin increases as it goes down-tiers (6.47 mm, 6.667 mm). Although the Haugh Unit did not change depending on the region ($P>0.05$), it was determined that the variation between the different cage-tiers was statistically significant ($P<0.05$). There is a negative relation between temperature-relative humidity and albumin height and Haugh Unit (Kılıç and Şimşek, 2006); also air quality may significantly affect the quality of the albumin (Altan, 2015). In accordance with these notifications, it is possible that as the cage-tier level increases, the temperature was found higher in the upper floors and the poor air quality in our study, so the height of the albumen may be low. Also, the decrease in the albumen height directly worsened the Haugh Unit. The high temperature negatively affects the albumin quality and HU. Especially, Haugh Unit was found lowest on 8^{th} cage tiers that because of high temperature and poor air quality. These results were found similar to Kirunda et al (2001). It was determined that the effect of the zones and cage tiers on egg yolk diameter and height was found statistically significant ($P<0.05$). These values in the last zone of the house and 8^{th} cage-tiers are the lowest in both parameters. However, yolk index was not significant ($P>0.05$). Kirunda et al. (2001) reported that the increase in temperature reduced the yolk quality. In our study, temperature changing was not affect yolk index, because temperature values were in thermal comfort zone (18-24 °C).

CONCLUSIONS

In our study, the relationship between the sensible temperature and some egg quality parameters were investigated in different zones and cage-tiers. External quality features were not influenced by sensible temperature but it affected some internal quality parameters such as an albumen and yolk quality. Haugh Unit is an important quality parameter in commercial egg industry and it should be kept as high as possible for higher quality eggs. Egg weight and shell quality also important features for laying hen farms profitability. However, sensible temperature is not common in today's poultry houses, there is a need for more research about the effects of sensible temperature on yield and product quality.

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