MEAN SURFACE TEMPERATURE OF JAPANESE QUAIL EXPOSED TO DIFFERENT LEVELS OF AIR VELOCITY AND TEMPERATURE AT START OF LAY

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Abstract: The objective of this study was to evaluate the effect of different air velocities and temperature at the feeder on mean surface temperature of Japanese quail during the initial stage of laying. The experiment was carried out at the Center for Research in Environment and Agroindustry Systems Engineering (AMBIAGRO), Department of Agricultural Engineering, Federal University of Viçosa, Viçosa/MG, Brazil. A total of 216 Japanese quail in the initial laying phase were placed in four environmental chambers with different temperatures and air velocity, where they were housed and distributed randomly in 2 galvanized wire cages, with 3 partitions each and 27 birds/cage, and a density of approximately 155.6 cm^2/bird. The experimental design consisted of randomized blocks with replications of two treatments (air velocity at the feeder: 0, 1, 2, and 3 m/s and air temperature: 17, 23, 29 and 35°C). The mean surface temperature was analyzed by Two-Way ANOVA, with treatment means separated by the Tukey test ($P < 0.05$). There was a significant positive correlation between air temperature and mean surface temperature (MST). Air velocity is important in removing heat from the surface of birds.

Index terms: Cold stress, *Coturnix coturnix japonica*, heat stress, thermal sensation.

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INTRODUCTION

Quail egg production is emerging as a promising poultry sector because this species presents rapid growth and development, early sexual maturity, high productivity, low feed intake, longevity in egg production with minimal capital and managemental requirements (Bagh et al., 2016; Sakamoto et al., 2018).

According to Sousa et al. (2013), the air temperature range which best characterizes the thermal comfort zone for adult quail is around 23°C and may extend up to 26°C. Under conditions of heat stress, the use of techniques that facilitate the dissipation of internal heat in the production facilities is necessary to provide comfort and welfare of the birds. While heat stress has been a rising concern for producers and scientists, cold stress has also caused economic loss worldwide (Nguyen et al., 2016). Cold stress in homeothermic animals induces physiological responses that are a high priority and require a lot of energy to maintain body temperature (Aarif et al., 2013).

Temperature and air velocity in quail facilities are important factors to achieve maximum productive performance. According to Santos et al. (2017), effects of air velocity may alleviate heat stress in moderate to hot conditions but can exacerbate cold stress by excess convective cooling. The surface temperature is an important variable in welfare, serving as the physiological response of the bird to inadequate facilities conditions (Nascimento et al., 2011). According to Bonfim and Melo (2015), the physiological parameters of quail can be altered when exposed to different temperatures, outside of the thermoneutral condition. In thermal comfort conditions, the birds surface temperatures are associated with those of the facility surface temperature (Nascimento et al., 2014).

The objective of this study was to evaluate the effect of different air velocities and temperature at the feeder on mean surface temperature of Japanese quail (*Coturnix coturnix japonica*) during the initial stage of laying.

MATERIAL AND METHODS

All management procedures applied during the experimental period were approved by the Animal Welfare Committee that regulates animal ethic usage at the Federal University of Viçosa (UFV) (Protocol No.72/2015), Minas Gerais State, Brazil.

This study was carried out in environmental chambers of the Center for Research in Environment and Agroindustry Systems Engineering (AMBIAGRO), Department of Agricultural Engineering, Federal University of Viçosa, Viçosa/MG, Brazil. A total of 216 Japanese quails in the initial stage of laying were randomly placed in four environmental chambers and allocated in two galvanized wire cages with dimensions of 1 × 0.42 × 0.42 m (length × width × height). The cage had partitions with 27 birds/cage. This arrangement provided an approximate density of 155.6 cm²/bird.

The air velocity system was placed in each environmental chamber, establishing four treatments with mean velocities of 1.0 m/s (Chamber 1); 2.0 m/s (Chamber 2); 3.0 m/s (Chamber 3); and 0.0 m/s (Chamber 4 - Control) at the feeders. This was accomplished using a PVC pipe with dimensions of 1.0 m (L) x 0.10 m (W), with a slot cut in the central region to direct air onto the birds. Each air velocity system used 2 axial-flow fans with plastic propellers and diameters of 23 cm; each with a 50W Elgin micromotor and volumetric flow rate of 950 m^3/h.

Each temperature treatment was assigned to the four climatic chambers over time, as follows: 3 days of treatment (23, 17, 29, 35°C) and 2 days of acclimation at 23°C (Sousa et al., 2013) between treatments. Temperature treatment order was randomized, with all chambers receiving the same temperature at the same time.

The mean surface temperature (MST) was recorded during three consecutive days for each treatments and combinations. MST was measured in 2 randomly birds/partition twice a day using a digital infrared thermometer (Model TI-860, Instrutherm, São Paulo SP, BR) with a measuring range between -30 and 270ºC, reading accuracy of 5%, resolution of 1°C, and fixed emissivity at 0.95. MST was. The MST was computed as proposed by Richards (1971) (Equation 1):

$$MST = \left(0.12T_{wing}\right) + \left(0.03T_{head}\right) + \left(0.15T_{leg}\right) + \left(0.70T_{back}\right) \quad (1)$$

where T_{wing}, T_{leg}, T_{back} and are respectively the wing, head, leg and back temperatures, all in °C.

The experimental design consisted of randomized blocks (cages within chambers) with replication (sections in cages) with two treatments (fixed air velocity per cage of 0, 1, 2, and 3 m/s and randomly assigned air temperature to all chambers: 17, 23, 29 and 35°C). Mean surface temperature was analyzed by two-way ANOVA, for main effects and interactions using the Tukey test ($P < 0.05$). The statistical analysis was performed using SigmaPlot (version 12.0, Systat Software, Inc., 2009).

RESULTS AND DISCUSSION

The mean surface temperature (MST) obtained under different treatments is provided in Table 1. It was noted that air temperature had

Table 1: Mean values of mean surface temperature (MST, °C) to evaluate the effect of air temperature (considering all velocities values) and air velocity (using all temperature values).

Temperature (°C)	Velocity (m/s)				Mean[1]
	0	1	2	3	
17	25.6 [Aa]	23.4 [Ab]	21.6 [Ac]	20.7 [Ad]	22.8 ± 2.2 [A]
23	33.2 [Ba]	31.5 [Bc]	30.2 [Bb]	30.5 [Bb]	31.4 ± 1.4 [B]
29	41.9 [Ca]	39.3 [Cb]	39.8 [Cb]	40.9 [Cc]	40.5 ± 1.2 [C]
35	48.2 [Da]	45.7 [Db]	47.4 [Dc]	47.9 [Dac]	47.3 ± 1.1 [D]
Mean[1]	37.2 ± 9.9 [B]	35.0 ± 9.7 [A]	34.8 ± 11.2 [A]	35.0 ± 11.9 [A]	

[1] Main effect means (Velocity or Temperature) followed by same uppercase letter do not differ by Tukey test ($P < 0.05$).
[a-c] Means followed by the same letter do not differ statistically between each other, uppercase in the column (air temperature means by velocity) and lower case in the row (air velocity means by air temperature), by Tukey test ($P < 0.05$).

a strong influence on MST of Japanese quails. MST increased significantly ($P < 0.05$) as the air temperature increased, with a mean of 24.5°C (over all velocities) varying from 17 to 35°C. By evaluating the average over all temperatures, MST decreased with increasing air velocity, but no differences ($P > 0.05$) were observed between 1, 2 and 3 m/s. With increased air velocity levels, the MST tended to be lower, presumably due to the convective heat removal capacity of the moving air.

A strong effect of air velocity at each temperature was noted ($P < 0.05$), with the lowest MST values found at air velocity of 2 m/s followed by 3 m/s independent of the evaluated air temperature. Ruzal et al. (2011) observed that the surface temperature of laying birds, exposed to air velocities of 0.5, 1.5 and 2 m/s at 35°C, was higher than that at 3 m/s.

It is worth noting that the 35°C condition associated with the air velocity of 0 m/s resulted in highest mean surface temperature of the birds during the experiment, while the combination of 17°C and 3 m/s air velocity presented the lowest MST values, 48.2°C and 20.7°C respectively (Table 1). Souza Júnior et al. (2013) evaluated the surface temperature of Japanese quail under air temperature below 18, between 18 and 22, and above 22°C, obtaining mean values of 24.7, 25.1 and 25.8°C respectively. Therefore, compared to the results of this experiment, similarities were found only with the 17°C treatment, with a value of 25.6°C for the control treatment of air velocity.

The strong effect of the air movement shows how air velocity decrease the average surface temperature at low temperatures, especially when high levels are applied. According to May et al. (2000), high air velocity is beneficial in hot environments, but may be detrimental under cold weather if heat loss is excessive. In this sense, Bottcher et al. (1995) reported that air velocity of at least 2.0 m/s is important to reduce the temperature of birds in hot environments and attenuate the thermal stress. This fact corroborates with the data found in this work because it shows variation in MST as the air temperature variation occurs. This can be explained by the difficulty that birds have of dissipating internal heat to the environment at high temperatures, causing their surface temperature to rise.

CONCLUSIONS

There was a significant positive correlation between air temperature and mean surface temperature. Air temperature had a strong influence on MST of Japanese quails This study demonstrated that air velocity at the feeder is important for removal of heat from the surface of the birds.

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