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Correlations between body surface, rectal temperatures and the average weight of broilers

Correlações entre as temperaturas da superfície corpórea e retal e os pesos médios de frangos de corte

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ABSTRACT

Body temperature is one of the indicators of broilers' susceptibility to thermal stress, which can compromise performance. This study aimed to evaluate correlations between both the surface and rectal temperatures, besides the average weight of broilers assessed in different ages. Temperatures of broilers' back, breast, and rectum were evaluated, besides the average weight of broilers at 7, 14, 21, and 35 days old. One hundred birds were assessed for each evaluation age, and the variables were submitted to Pearson's correlation analyses. The rectal temperature had a correlation with the breast one when the birds were evaluated at 7 and 14 days old. The average weight correlated only with rectal and breast temperatures at 14 and 21 days old, respectively. The correlations between the temperatures were weak or insignificant in most of the studied ages. Therefore, the skin temperature is not a suitable parameter for measuring broilers' temperature compared to the rectal one, so the use of infrared thermometer did not prove to be a useful strategy to estimate the internal temperature of broilers.

KEYWORDS: ambiance; metabolism; thermal comfort; thermoregulation.

RESUMO

A temperatura corporal é um dos indicadores de suscetibilidade dos frangos de corte ao estresse térmico, o que pode comprometer o desempenho. Este estudo teve como objetivo avaliar as correlações entre as temperaturas superficial e retal, além do peso médio de frangos de corte avaliados em diferentes idades. Foram avaliadas as temperaturas do dorso, peito e reto das aves, além do peso médio das aves aos 7, 14, 21 e 35 dias de idade. Cem aves foram avaliadas para cada idade de avaliação, e as variáveis foram submetidas à análise de correlação de Pearson. A temperatura retal apresentou correlação com a do peito quando as aves foram avaliadas aos 7 e 14 dias de idade. O peso médio correlacionou-se apenas com as temperaturas retal e do peito aos 14 e 21 dias de idade, respectivamente. As correlações entre as temperaturas foram fracas ou insignificantes na maioria das idades estudadas. Portanto, a temperatura da pele não é um parâmetro adequado para medir a temperatura de frangos de corte em comparação com a retal, de modo que o uso de termômetro infravermelho não se mostrou uma estratégia útil para estimar a temperatura interna de frangos de corte.

PALAVRAS-CHAVE: ambiência, conforto térmico, metabolismo, termorregulação.

Industrial poultry farming had many modifications through the recent decades, highlighted by progress in genetics, nutrition, animal health, and management, besides technologies and ambiance. As a result, modern broilers display a fast growth added to great feed efficiency and carcass yield (TICKLE & CODD 2019). Nevertheless, these performance improvements led to a significant increase in heat increment caused by massive metabolic rates and developments of viscera, respiratory and cardiovascular systems (GILOH et al. 2012, ZABOLI et al. 2019).

According to CÂNDIDO et al. (2020), the thermic comfort for homoeothermic animals, such as broilers, is characterized by the environmental temperature interval. Within this interval, there is the least energy expenditure to maintain the body temperature. Thermic comfort temperature varies according to the birds'

age, and birds at the initial phases have low feathers added to a thermoregulation center not completely developed. Thereby, higher environmental temperatures are needed (MARGATO NETO et al. 2021). Since the birds grow and develop themselves, there is a heat production increase by their bodies and completes feather formation and thermoregulation center. Considering that, losing heat is hard for these birds, and lower environment temperatures are demanded (MARGATO NETO et al. 2021).

GOEL et al. (2021) stood out that the body temperature is a marker of thermic stress since this parameter varies in homeothermic animals when the environmental temperature exceeds that comfort one. Under stress conditions by heat, blood flow occurs from the central regions of the body to the skin surface (NASCIMENTO et al. 2014). Thereby, there is a direct association between the increases in environmental, inner body, and skin temperatures (GILOH et al. 2012). Any variation in the environmental temperature will affect the biological partition of energy, providing modifications in this bioavailability for the animals' physiological functions (FERREIRA 2019).

Rectal and surface temperatures must also be considered as physiological indicators to allow the search for animal thermic comfort (DAMANE et al. 2018). The rectal temperature is the most accurate regarding the true animal's temperature but requires more labor and invasive management, which can result in stress-induced hyperthermia (GILOH et al. 2012, BLOCH et al. 2020). Conversely, the skin temperature can be measured quickly and easily with the aid of infrared thermometers. Nevertheless, surface temperature may vary according to the birds' age and environmental factors such as air temperature, temperature humidity index, relative humidity, and air velocity (AKTER et al. 2022).

Measurements of birds' rectal temperature can work as a powerful parameter of decision-making in commercial poultry farms, mainly considering thermic stress assessments (ABREU et al. 2019). According to ABREU et al. (2017), when there are variations in body surface and rectal temperatures, broilers dissipated or retained heat, and because of this, part of the energy that should be used to gain weight ends up being utilized in the thermoregulatory process leading to reductions in performance (ANDRETTA et al. 2021).

Based on this context, this study aimed to evaluate the correlations between both the surface and rectal temperatures, besides the average weight of broilers assessed in different ages. Considering that the traditional assessment of body surface temperature, made through the rectum, requires birds' manipulation and pondering that there is a strong correlation between rectal and surface temperatures, this last one can work as a substitute in order to make this ascertainment easier and less invasive for these animals.

The experiment was carried out at the Poultry Sector of Federal Rural University of Rio de Janeiro (UFRRJ), located at Seropédica municipality (22° 44' 38'' S and 43° 42' 27'' W), and lasted from 04/19/2021 to 05/23/2021. All procedures were made with the authorization of the Ethics Committee about the use of animals from the Animal Science Institute (CEUA-IZ) of UFRRJ (protocol number 0118-05-2021). One thousand male one-day-old broilers from the Cobb lineage were caged into experimental poultry shed covered with wood shavings, and with a density of eight broilers per m^2. Birds were submitted to the same management conditions and feeding, since the first day of life, with isoproteic and isoenergetic diets based on soybean meal and ground corn. These diets attended to birds' nutritional requirements according to the Cobb lineage manual (COBB-VANTRESS 2018a).

Temperatures and body weight were measured at 7, 14, 21, 28, and 35 days old. In each evaluation day, one hundred broilers were aleatory selected, at 8:00 a.m., and then these one hundred birds were weighted individually, and temperature of each broiler measured. Surface temperature measurements were done on the birds' backs with an infrared thermometer (GW-100 Model, with an error margin of 0.2 °C) while the rectal temperature was assessed with a digital thermometer with 0.1 °C of precision. Furthermore, the body weight was measured on a digital bench scale with 40-kg capacity and 2-g precision.

Linear Pearson correlations among all variables were analyzed with the PROC CORR from SAS® OnDemand for Academics. All results were considered significant at 5% of probability of error.

Both air humidity and average temperatures in the shed and in the birds (back, breast and rectum), which were measured at 7, 14, 21, and 35 days old, are described in Table 1. The highest temperature reported in the shed was observed at the first week-old of birds (27.8 °C). In addition, the lowest air humidity (50.0 °C) was verified at the third week (21 days old).

In the pre-initial phase (7 days old), a weak correlation was verified (Table 2) between the back and breast temperatures of the birds ($r = 0.3113$). In addition, the correlation between breast and rectum temperatures was also weak ($r = 0.2322$). Other variables had no significant correlations. At 14 days old (Table 2), the rectal temperature moderately correlated with the bird breast temperature ($r = 0.4375$), and weakly with the broiler weight ($r = 0.2718$).

Table 1. Shed temperature, and temperatures of birds' back, breast, and rectum (°C), besides the average broilers' weight (g).

Age (days)	Shed temperature (ºC)	Air humidity (%)	Back temperature (ºC)	Breast temperature (ºC)	Rectal temperature (ºC)	Broiler's weight (g)
7	27.8	70	33.28 ± 1.54	35.82 ± 1.09	40.80 ± 0.38	188.78 ± 21.28
14	26.5	65	32.24 ± 1.80	34.93 ± 0.89	40.93 ± 0.38	467.49 ± 50.80
21	25.7	50	33.95 ± 1.85	34.86 ± 1.31	41.05 ± 0.36	894.20 ± 85.40
28	23.8	65	32.87 ± 1.80	35.96 ± 1.82	41.37 ± 0.39	1544.27 ± 134.53
35	24.3	75	29.89 ± 2.73	34.03 ± 0.70	40.78 ± 0.40	2300.00 ± 200.50

Table 2. Pearson's linear correlation between birds' back, breast, and rectum temperatures, besides the average broilers' weight at 7 and 14 days old.

Temperature (ºC)	Back (ºC)	Breast (ºC)	Rectum (ºC)	Broiler's weight (g)
		7 days old		
Back	-	0.3113	ns	ns
Breast	-	-	0.2322	ns
Rectum	-	-	-	ns
		14 days old		
Back	-	ns	ns	ns
Breast	-	-	0.4375	ns
Rectum	-	-	-	0.2718

ns – Non-significant results according to Pearson's linear correlation.

At 21 days old, the average birds' weight significantly correlated (r = 0.2186) with the bird's breast temperature (Table 3). However, other measured temperatures did not have significant correlations.

Table 3. Pearson's linear correlation between birds' back, breast, and rectum temperatures, besides the average broilers' weight at 21, 28 and 35 days old.

Temperature (ºC)	Back (ºC)	Breast (ºC)	Rectum (ºC)	Broiler's weight (g)
		21 days old		
Back	-	ns	ns	ns
Breast	-	-	ns	0.2186
Rectum	-	-	-	ns
		28 days old		
Back	-	0.3321	ns	ns
Breast	-	-	ns	ns
Rectum	-	-	-	ns
		35 days old		
Back	-	ns	ns	ns
Breast	-	-	ns	ns
Rectum	-	-	-	ns

ns – Non-significant results according to Pearson's linear correlation.

Pearson's linear correlations between the average birds' weight, and breast and rectum temperatures were not significant (Table 3) at 28 days old. Nevertheless, the back temperature of broilers was significantly correlated with the rectal one (r = 0.3321).

Similar to the 28th day of evaluation, the average broilers' weight had no significant correlations with the measured temperatures at 35 days old (Table 3). Interestingly, there were no significant correlations between measured temperatures in 35 days old broilers.

In the first two weeks, shed temperature and air humidity followed the recommendations of the Cobb lineage manual (COBB-VANTRESS 2018a), which were 26 °C and 60%, respectively, at 14 days old.

According to ABREU et al. (2019), the comfort temperature of broilers, from the third to sixth week of life, varies from 20 to 26 °C. Considering this, the broilers were under inadequate climate conditions at 35

days old. Also, the air humidity was higher in the final periods of broilers' rearing (65 and 75%). How greater the air humidity, less water will be removed from the bird's respiratory system, and the respiration will become more panting to compensate for the lower amount of water expelled (MASCARENHAS et al. 2018, FERREIRA 2019). These facts were observed in the present study, and the broilers showed panting behaviour in the last weeks.

Body surface temperatures measured in the back and in the breast of broilers were similar to those described by NASCIMENTO et al. (2014) and CÂNDIDO et al. (2020). Concerning the rectal temperatures (Table 1), they denoted an adequate thermoregulatory mechanism, with production and dissipation of heat to maintain the body temperature at about 41 °C (FERREIRA 2019). In addition, the average weights of broilers were similar to those expected for the Cobb lineage, regardless of the birds' age (COBB-VANTRESS 2018a).

Broilers reared out of their thermic comfort zone display improper performance in face of the genetic potential, with reductions in feed intake, weight gain, and feed conversion (SANTOS et al. 2020). The obtained results in the present study, regarding the birds' weight, suggested that the broilers maintained their homeostasis and body temperatures, with no disturbance in production performance.

The lack of correlations between surface temperatures and the average weight of birds, in the first week of life (Table 2), can be explained by the physiological traits of neonates that do have not a complete thermoregulatory system, and they have no feathers too (MARGATO NETO et al. 2021). FERRAZ et al. (2019) identified an age effect on both body surface and air temperatures, which differed for regions with and without feathers.

At 14 and 21 days old, the average weights had correlations with rectal and breast temperatures, respectively. These results likely occurred because of the birds' physiological phase. FERREIRA (2019) reported that a modern broiler reaches its thermoregulatory ability from 10 to 15 days old.

Body temperatures and broilers' weight had significant correlations at 28 and 35 days old (Tables 3). These findings differed from those reported by GILOH et al. (2012). The authors observed a great correlation between rectal and skin temperatures, from eight to 36 days old, regardless of the production system assessed (0.86 for non-acclimatized sheds, and 0.91 for acclimatized ones). As the age of birds increases, the responses of body temperature in face of environmental changes remained constant (GILOH et al. 2012).

Correlations between skin temperature and inner temperatures likely are related to the body temperature increase that provides vasodilatation and makes the warm blood migrate from the inner organs to the marginal regions. This blood flow reduces the inner body temperature but increases that one from the skin. The magnitude of these effects may vary with thermoregulatory and energetic context, that may be influenced by corticosteroid hormones, for example (HERBORN et al. 2018).

It is worth pointing out that the shed temperature, and other related variables, influenced the birds' temperature, and their thermic comfort and performance. Thereby, the temperature variations of birds' bodies indicate that the body surface alterations were insufficient to maintain the thermic equilibrium (ABREU et al. 2017). Considering that most birds' temperatures did not correlate with body weight at 21 and 35 days old (Tables 3), no significant physiological changes can be suggested.

The main correlations between body temperatures (back, breast and rectum), and the average body weight of broilers, were identified in the initial and growth phases (14 and 21 days, respectively), periods when the broilers completed their thermoregulatory ability. Nevertheless, the correlations were weak or not significant in the most of ages assessed. Therefore, the skin temperature measured through an infrared thermometer is not suitable alternative to scouting broilers' temperature, mainly compared to the rectal one.

The evaluated broilers maintained the body homeostasis of temperature, with no prejudice in production performance. Measurement by infrared thermometer on broiler surface did not prove to be viable as a substitute for rectal thermometer. So when evaluating thermic stress in a commercial flock, skin temperature should be avoided.

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