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Short Communication

Bands of respiratory rate and cloacal temperature for different broiler chicken strains

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ABSTRACT - The objective of this investigation was to estimate ideal bands of respiratory rate and cloacal temperature for broiler chicken strains during the rearing period and to evaluate the influence of time of exposure on bird physiological variables under different thermal stress conditions. The research was conducted in a climatic chamber during the six weeks of the rearing period, with Avian and Cobb strains exposed to two climatic conditions (comfort and stress), in three distinct times of exposure, in three conditions (before going to the chamber; at the end of exposure time; 30 minutes after the end of exposure), in four treatments: comfort with 60 minutes of exposure; stress with 30 minutes of exposure; stress with 60 minutes of exposure; stress with 90 minutes of exposure. Bands of respiratory rate and cloacal temperature were elaborated for both strains, for each one of the weeks of the rearing period. Strains differed, regardless of treatments and conditions adopted in the research on the third, fifth and sixth weeks of life in relation to the cloacal temperature. The Cobb strain is more tolerant to thermal stress in comparison with the Avian. There was difference for both variables between comfort and stress, but time of exposure to stress did not influence the physiological response of birds, except for cloacal temperature on the second week of life.

Key Words: poultry, physiological variables, thermal comfort

Introduction

Physiological variables can be used to measure the condition of thermal comfort of the animals. Any variation in them is an indicative of attempts to maintain thermal equilibrium, and consequently, if the animal is or not under thermal stress. Respiratory rate and cloacal temperature are variables widely used and considered the simplest ones for the evaluation of physiological conditions of animals (Bianca & Kunz, 1978). Respiratory rate is a variable of easy measurement, which can be through visual analysis; the second one, can be measured through the use of mercury clinical thermometers (Dahlke et al., 2005), or through the use of electronic dataloggers (Brown-Brandtl et al., 2003).

It is necessary to emphasize that physiological characteristics of broiler chickens change during their life, and many authors define an unique respiratory rate band for all the rearing period, varying from 20 breaths.min^{-1} (Swick, 1998), to 40 breaths.min^{-1} (Hoffman & Volker, 1969). Marchini et al. (2007) defined bands of respiratory rate and cloacal temperature to broiler chickens in each one of the weeks of the rearing period, varying from 48 breaths.min^{-1} in the first week to 42 breaths.min^{-1} in the sixth week. Broilers present a significant increase of respiratory rate under high temperatures, and values up to 165 breaths per minute to broilers at 42 days of age have been reported (Silva et al., 2007).

The same can be applied to cloacal temperature, in which any variation indicates that heat exchanges on body surface are not sufficient to the maintenance of thermal equilibrium. In the literature, there are also many indications about the ideal values for broiler chickens, varying between 41 and 42 °C for a comfort condition (Elson, 1995), and values up to 46 °C to thermal stress conditions at 42 days of life (Silva et al., 2007); in this situation, the broilers died.

It must be considered that these animals can return to initial pre-stress condition or even die, as a function of the time of exposure to stress and of characteristics of birds, such as age, strain and live weight. Although some research studies describe these effects, there is a need to establish the ideal correspondence bands between exposure times to a certain stress or comfort condition, for the different weeks of the rearing period, without causing productive losses.

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The objective of the present investigation was to estimate bands of respiratory rate and cloacal temperature for two strains under comfort and stress situations, during the six weeks of the rearing period, and to evaluate the influence of time of exposure on physiological responses of broilers under different thermal stress conditions.

Material and Methods

The research was conducted in the climatic chamber of Núcleo de Pesquisa em Ambiência (NUPEA), from the Department of Biosystems Engineering of ESALQ/USP. Two commercial broiler strains were used (Cobb and Avian), exposed to two climatic conditions (comfort and stress), during three distinct times of exposure (30, 60 and 90 minutes). The response variables were respiratory rate and cloacal temperature.

Ninety-six birds were used weekly, totalizing 584 birds at the end of the trial, divided in four flocks of 24 animals, composed of 12 birds of each strain (as experimental unit). The flocks were subjected to one treatment per day; thus, the first four days of each week of the rearing period were evaluated. Birds were distributed in pens with 1 m^2, at a density of 12 birds/m^2. Birds were maintained in an aviary from the Department of Genetics of ESALQ/USP during the cycle, and they were transferred to the climatic chamber only in the evaluation days, receiving water and feed *ad libitum*.

Flocks were homogeneous, of both gender and the animals were randomly distributed between the studied flocks. Macari & Furlan (2001) proposed comfort and stress bands for broiler chickens through the six weeks of the rearing period. Based on these pieces of information, experimental comfort and stress conditions were pre-determined (Table 1).

Air temperature and air relative humidity were measured inside the climatic chamber by the use of sensors connected to dataloggers (Hobo®), installed at the height of birds, at intervals of 10 minutes.

Table 1 - Limit bands of experimental conditions of temperature (T) and relative humidity (RH) of the six weeks of the rearing period of broiler chickens, in controlled environment

Age (weeks)	Comfort condition		Stress condition	
	T (°C)	RH (%)	T (°C)	RH (%)
1	34	60	30	80
2	31.5	60	25	80
3	28.5	60	38	80
4	25.5	60	37	80
5	23	60	36	80
6	22.5	60	35	80

The exposure of birds to different conditions was done at several permanence times for the studied condition, due to the fact that time of exposure to stress influences the thermal sensation of the animals, and consequently, their physiological responses (Silva et al., 2007). Time of exposure to stress was based on the results of Yanagi Jr. et al. (2001), which considered 20 minutes as the minimal time of exposure, presuming this as the necessary time for birds to acquire stability of the thermoregulatory processes; also, in the study of Silva et al. (2007), the authors observed that broilers at 42 days of age presented an increase in their physiological parameters after 30 minutes of exposure to high temperature and relative humidity, which indicated unbalance and thermal stress.

Based on this information, the following treatments were established for each one of the weeks of the rearing period: comfort with 60 minutes of exposure; stress with 30 minutes of exposure; stress with 60 minutes of exposure; and stress with 90 minutes of exposure.

Broilers were evaluated in three different conditions: before the beginning of exposure; at the end of exposure; and 30 minutes after the end of the exposure, to observe if 30 minutes is enough time for the animals to return to the initial condition, before the exposure to the climatic conditions. All thermal conditions were performed on the same day, i.e., each one of the flocks was subjected to one treatment per day. Climatic conditions in pre-chamber were not controlled (Table 2).

Cloacal temperature was obtained by introducing a digital thermometer into the cloaca of birds, until the stability of reading. Respiratory rate was measured by the counting of panting breaths of the birds for 15 seconds, and this value was multiplied by 4, so it was possible to obtain the number of respiratory breaths by minute.

Data from physiological variables were submitted to analysis of variance using PROC GLM of SAS (Statistical Analysis System, version 9.2), and adjusted means were compared by the Tukey test, at 0.05 of probability. A 4 × 4 Latin square design composed of the four flocks of birds and the four treatments was adopted. The statistical model is described below:

$$Y_{ikmn} = \mu + g_i + t_k + r_{ik} + l_m + tl_{km} + \delta_{ikm} + c_n + tc_{kn} + lc_{mn} + tlc_{kmn} + \varepsilon_{ikmn}$$

in which: Y_{ikmn} = n-th observation from cloacal temperature and respiratory rate evaluated in the I-th flock, at the k-th treatment, in the m-th strain, in the n-th environmental condition; g_i = fixed effect of the i-th flock (i 1,...,4); t_k = fixed effect of the k-th treatment (k comfort with 60 minutes of exposure; and stress with 30, 60 or 90 minutes of exposure); r_{ijk} = random error of flocks and treatments; l_m = fixed effect of the m-th strain (m Avian or Cobb); tl_{km} = effect

Table 2 - Bands of experimental conditions of temperature and relative humidity of the weeks of age of broiler chickens in the antechamber, without environment control

Age (weeks)	Before the beginning of the exposure		30 minutes after leaving the chamber	
	Temperature (°C)	Relative humidity (%)	Temperature (°C)	Relative humidity (%)
1	29,2	60	30	60
2	29,5	60	29,5	60
3	28,4	60	29,3	50
4	27,8	70	27,7	70
5	26,5	70	26,9	70
6	27,7	70	28,4	60

of the interaction between the k-th treatment and the m-th strain; δ_{ijkm} = random error of flocks, treatments and strains and of the interaction between treatments and strains; c_n = fixed effect of the n-th environmental condition (n measurement before going to the chamber, measurement after the exit of chamber and measurement 30 minutes after the exit of climatic chamber); tc_{kn} = effect of the interaction between the k-th treatment and the n-th environmental condition; lc_{mn} = effect of the interaction between the m-th strain and the n-th environmental condition; tlc_{kmn} = effect of the interaction between the k-th treatment and the m-th strain and the n-th environmental condition; ε_{ikmn} is the residual term, which includes the other sources of variation not considered in the model, besides the determination error; μ = parametric mean.

Recommended values of respiratory rate and cloacal temperature through the rearing period were stipulated for the strains based on observed values after the exposure to the treatments.

Results and Discussion

For the 1st and 2nd weeks, there was no significant difference (P>0.05) between strains, thermal conditions (comfort with 60 minutes of exposure; and stress with 30, 60 or 60 minutes of exposure), and climatic conditions (before the beginning; at the end; and 30 minutes after the end of the exposure), which indicates that broilers present similar profiles of respiratory rate in the first 14 days of life. It was verified that time of exposure to the stress condition did not influence the response of the animals.

Both strains presented in the first week an average of 47 breaths.min^{-1}, and in the second week of the rearing period an average of 58 breaths.min^{-1} (Avian) and of 60 breaths.min^{-1} (Cobb). The results agree with those found by Marchini et al. (2007), which described average values of 48 and 57 breaths.min^{-1} for the 1st and 2nd weeks, respectively.

Significant results (P<0.05) for the treatments, conditions before and after the exposure to stress and to the interaction between treatments and conditions were observed in the interval between the 3rd and 6th weeks of age.

The variation between the stipulated conditions was also calculated: the difference between the end and the beginning of exposure (Δ1); the difference between 30 minutes after the end and the end of exposure (Δ2); and the difference between 30 minutes after the end and before the beginning of exposure (totalΔ), to verify if whether or not animals were able to return to the initial condition (Table 3).

Broilers were able to significantly decrease their respiratory breaths in the period from the 3rd to the 6th weeks after the exposure to the comfort condition, once the environment in which they were before going to the chamber was not controlled. An average reduction of 22 breaths.min^{-1} was observed in the 3rd week (equivalent to a reduction of 27% in respiratory rate); and of 13 (19% of reduction), 0 (0% of reduction) and 39 (43% of reduction) breaths.min-1 on the 4th, 5th and 6th weeks, respectively. Besides, it was also verified that respiratory rate changed significantly (P<0.05) between the comfort and thermal stress conditions (stress with 30, 60 or 90 minutes of exposure), and there was increase in respiratory rate during these weeks of the rearing period, regardless of the time of exposure, as expected. These results showed that 30 minutes of exposure was enough time for broilers to significantly change their respiratory rate, which is in agreement with the results of Yanagi Jr. et al. (2001).

In relation to the return time (30 minutes after the end of exposure), broilers from the 4th to the 6th weeks were capable to return to the initial condition of respiratory rate (before the beginning of exposure), even after 90 minutes of exposure. In the sixth week, no significant difference was verified between the values of respiratory rate in the three studied conditions (before the beginning, at the end and 30 minutes after the end of the exposure) for stress with 30 and 60 minutes of exposure, possibly because the environmental condition of laboratory was higher than comfort condition, once it was not controlled.

Table 3 - Respiratory rate to the third, fourth, fifth and sixth weeks of the rearing period of the thermal stress conditions in the three studied conditions and the variations between the climatic conditions of Avian and Cobb strains

Week	Thermal condition	Exposure time: Beginning of exposure	End of exposure	30 minutes after the end of exposure	Variation: Δ1	Δ2	TotalΔ
3rd	C60	81±6Aa	59±6Bb	80±6Ba	-22	21	-1
	S30	80±6Ab	137±6Aa	89±6Bb	57	-48	9
	S60	68±6Ac	146±6Aa	89±6Bb	78	-57	21
	S90	75±6Ac	151±6Aa	102±6Ab	76	-49	27
4th	C60	69±11Aa	56±6Ba	57±3Ba	-13	1	-12
	S30	63±11Ab	138±6Aa	68±3Ab	75	-70	5
	S60	69±11Ab	128±6Aa	71±3Ab	59	-57	2
	S90	63±11Ab	137±6Aa	76±3Ab	74	-61	13
5th	C60	51±11Bb	51±11Bb	84±11Aa	0	33	33
	S30	58±11Bb	100±11Aa	72±11Ab	42	- 28	14
	S60	59±11Bb	123±11Aa	76±11Ab	64	-47	17
	S90	85±11Ab	114±10Aa	56±11Ab	29	-58	-29
6th	C60	91±13Aa	52±13Ba	55±13Ba	-39	3	-36
	S30	96±13Aa	108±13Aa	75±13Aba	12	-33	-21
	S60	81±13Aa	120±13Aa	98±13Aa	39	-22	17
	S90	62±13Ab	123±13Aa	80±13ABb	61	-43	18

C60 = comfort with 60 minutes of exposure; S30 = stress with 30 minutes of exposure; S60 = stress with 60 minutes of exposure; S90 = stress with 90 minutes of exposure; Δ1 = difference between the end and the beginning of exposure; Δ2 = difference between 30 minutes after the end of exposure; TotalΔ = difference between 30 minutes after the end and before exposure; SE = standard error.
Means followed by the same capital letters in the column and lowercase letters in the row are not different (P<0.05) by the Tukey test.

In the 3rd week, birds returned to initial condition only after the condition stress 30 minutes of exposure; for the conditions stress with 60 and 90 minutes of exposure there was a significant difference (P<0.05) between before the beginning, at the end and 30 minutes after the end of the treatments, i.e., despite birds decreasing their respiratory rate after 30 minutes, it was not sufficient to achieve mean statistical values similar to condition before the beginning of treatments.

This is an indicative that the 3rd, 5th and 6th weeks of the rearing period can be considered the most critical, once a significant difference (P<0.05) was observed between the strains only in these weeks (Table 4).

The results showed that the Avian strain presented higher mean values of respiratory rate than Cobb. Yahav et al. (1998) affirm that strains with higher values of respiratory rate and cloacal temperature under thermal stress conditions are least tolerant to the heat. Therefore, it is an indicative of a higher tolerance of Cobb broilers to the heat, based only on the respiratory rate. The results also have an importance due to the fact that these differences occurred in the most critical weeks of the rearing period of broiler chickens. It is known that the animals present a complete development of thermoregulatory system after the 14th day of age, i.e., a maturation of the thermoregulatory mechanisms (Lin et al., 2005), which also results in an increase in the tolerance to cold, and a higher sensibility to the heat.

Table 4 - Respiratory rate of Avian and Cobb strains in the 3rd, 5th and 6th weeks of the rearing period

Age (weeks)	Respiratory rate (breaths.min^{-1}): Avian	Cobb
3rd	99±2A	93±2B
5th	82±3A	73±3B
6th	92±3A	81±3B

SE = standard error.
Means within a column with no common letters in each one of the weeks differ significantly (P<0.05).

It was possible to elaborate bands of respiratory rate values to each one of the weeks of the rearing period for both studied strains, based on these results and on the experimental conditions adopted in this research (Table 5). Strains presented similar bands, because they were based on condition 2 (at the end of the treatments), which made it possible to state that broilers were subjected to a comfort or stress situation. Respiratory band between 40 and 60 breaths.min^{-1} was observed for all the rearing period, considering a thermal comfort condition to broiler chickens.

In relation to the cloacal temperature, in the first week of the rearing period there was no significant difference (P>0.05) between the strains and treatments, as also observed for respiratory rate. Both strains showed an average of 39.6 °C, which indicates that it is possible to adopt the same band of the variable for them at the beginning of the rearing period. The results found are in accordance

Table 5 - Mean values of respiratory rate (RR) recommended to the six weeks of the rearing period for Avian and Cobb strains, in comfort and thermal stress conditions

Age (weeks)	Comfort RR (breaths.min^{-1})		Thermal stress RR (breaths.min^{-1})	
	Avian	Cobb	Avian	Cobb
1st	48	48	48	48
2nd	58	60	58	60
3rd	59	59	137 to 151	137 to 151
4th	56	56	128 to 138	128 to 138
5th	51	51	100 to 123	100 to 123
6th	52	52	108 to 123	108 to 123

with those observed by Malheiros et al. (2000), who reported values between 39.7 °C and 41.2 °C for Cobb broilers in the first week of the rearing period.

In the second week there was a significant difference (P<0.05) for the interaction between treatment and strain, which demonstrated that the response of broilers was directly related to the treatments, i.e., to the exposure time. It was observed that Cobb strain kept the cloacal temperature stable for all the studied treatments, and they did not differ significantly (P>0.05), varying from 41.08 °C for 60 minutes under the stress condition to 41.25 °C when subjected to 30 minutes of stress. However, the Avian strain showed to be more sensitive than Cobb, presenting lower cloacal temperature in stress with 90 minutes of the exposure (P<0.05). This fact can indicate that Avian broilers are more sensitive to cold thermal stress, whose condition did not differ statistically (P>0.05) in relation to the comfort condition.

From the third week, there was a significant effect for the interaction between treatment and condition, and significant differences were observed at 5% between the comfort and stress conditions. The differences between the end and the beginning of exposure; 30 minutes after the end of exposure; and 30 minutes after the end and the beginning of the treatments were calculated, respectively (Table 6).

It was observed that after the comfort treatment, for all the weeks of the rearing period, broilers were able to decrease their cloacal temperature significantly, reaching values within the thermoneutrality band, with variations (Δ1) of 0.46, 0.08, 0.50 and 0.58 °C for the third, fourth, fifth and sixth weeks, respectively.

Therefore, an exposure of 60 minutes to the comfort was enough for broilers to return to the thermoneutrality condition, and cloacal temperature increased 0.34, 0.26 and 0.14 ºC, 30 minutes after the end of exposure, in the third, fourth and sixth weeks, respectively. There was a significant difference (P<0.05) between the comfort and the stress conditions, as expected. But there was no difference between the stress conditions, which indicates that the time of exposure did not influence the response of animals, as a function of cloacal temperature. The only exception was the fifth week, in which a significant difference (P<0.05) was observed for the exposure time. Broilers presented a lower clocacal temperature in stress with 30 minutes, differing from stress with 60 and 90 minutes of exposure.

Table 6 - Cloacal temperature of the third, fourth, fifth and sixth weeks of the rearing period of the thermal condition, in the three studied conditions and their respective variations

Week	Thermal condition	Exposure time			Variation		
		Beginning of exposure	End of exposure	30 minutes after the end of exposure	Δ1	Δ2	TotalΔ
3rd	C60	42.24±0.09Aa	41.78±0.09Bb	42.12±0.09Aa	-0.46	0.34	-0.12
	S30	42.28±0.09Ab	43.16±0.09Aa	42.32±0.09Ab	0.88	-0.84	0.04
	S60	42.12±0.09Ab	43.10±0.09Aa	42.33±0.09Ab	0.98	-0.77	0.21
	S90	42.02±0.09Ab	43.03±0.09Aa	42.27±0.09Ab	1.01	-0.76	0.25
4th	C60	42.49±0.30Aa	41.99±0.26bb	42.25±0.21Aab	-0.50	0.26	-0.24
	S30	42.16±0.30Ab	42.92±0.26Aa	42.20±0.21Ab	0.76	-0.72	0.04
	S60	42.32±0.30Ab	43.04±0.26Aa	42.13±0.21Ab	0.72	-0.91	-0.19
	S90	41.93±0.30Ac	42.93±0.26Aa	42.27±0.21Ab	1.00	-0.66	0.34
5th	C60	41.97±0.17Ab	41.89±0.08Cb	42.28±0.16Aa	-0.08	0.39	0.31
	S30	42.04±0.17Aab	42.29±0.08ba	41.95±0.16Ab	0.25	-0.34	-0.09
	S60	42.02±0.17Ab	42.63±0.08Aa	42.02±0.16Ab	0.61	-0.61	0.00
	S90	42.19±0.17Ab	42.54±0.08Aa	41.98±0.16Ab	0.35	-0.56	-0.21
6th	C60	42.31±0.15Aa	41.73±0.15bb	41.87±0.15Ab	-0.58	0.14	-0.44
	S30	42.42±0.15Aa	42.46±0.15Aa	42.02±0.15Ab	0.04	-0.44	-0.40
	S60	42.35±0.15Aa	42.61±0.15Aa	42.29±0.15Aa	0.26	-0.32	-0.06
	S90	42.10±0.15Ab	42.55±0.15Aa	42.18±0.15Ab	0.45	-0.37	0.08

C60 = comfort with 60 minutes of exposure; S30 = stress with 30 minutes of exposure; S60 = stress with 60 minutes of exposure; S90 = stress with 90 minutes of exposure; Δ1 = difference between the end and the beginning of the exposure; Δ2 = difference between 30 minutes after the end of the exposure; TotalΔ = difference between 30 minutes after the end and before the exposure; SE = standard error.
Means followed by the same capital letters in the column and lowercase letters in the row are not different (P<0.05) by the Tukey test.

This indicates that even 30, 60 or 90 minutes lead to physiological changes, as an attempt to maintain thermal equilibrium. The animals showed a higher sensibility to stress during the third week, with means over 43 °C, and this information is in agreement with Dionello et al. (2002), who suggest that a higher susceptibity to thermal stress can be associated to incomplete maturation of thermoregulatory system of birds.

These results follow those found by Silva et al. (2007), who described significant increase of cloacal temperature in broilers under an stress condition at different times of exposure (0, 30, 60, 90 and 120 minutes). Nevertheless, the authors observed a progressive increase of cloacal temperature in relation to the time of exposure, describing mean temperatures of 45 °C after 120 minutes of exposure at 35 °C and 85% of relative humidity.

Yahav & Hurwitz (1996) affirmed that acclimatized animals present lower core temperature under thermal stress (which can be represented by cloacal temperature) in comparison with birds without acclimatization. In this investigation, acclimatization was not used, so that the immediate effects of exposure of birds to a condition of thermal challenge could be tested.

After the exposure to stress in the third week, animals returned to their initial condition, represented by condition 3 (30 minutes after the end of treatments), as well as in the fourth week, when the animals returned to the initial condition, except for treatment S90, in which birds showed a lower mean during the experimental period, but were also able to decrease the cloacal temperature in 0.66 ºC (Δ2). Strains differed ($P<0.05$) in the sixth week of the rearing period, and the Avian strain had an average of 42.29 ºC and Cobb strain of 42.19 ºC.

This result confirms a higher tolerance of the Cobb strain to heat, which can also be verified by respiratory rate, once the Avian strain showed higher values than Cobb during the last week of the rearing period. During the sixth week there was a significant difference ($P<0.05$) of strains in relation to the studied conditions.

A higher value of cloacal temperature to Avian strain in relation to Cobb ($P<0.05$) was observed (Table 6) for conditions 1 and 2 (beginning and end of the treatments), which means that Avian broilers are less tolerant to the heat, regardless of time of exposure, but the Cobb strain showed similar values 30 minutes after the end of exposure. The Cobb strain did not differ ($P>0.05$) betwen the three conditions. Higher values of the Avian strain is another indicative of its minor tolerance to heat stress. However, with the data obtained in this study, for the environmental conditions adopted in it, it was possible to elaborate bands for the conditions of comfort and stress for broiler chickens from the Avian and Cobb strains, based on the condition 2 (end of the treatments), for all the weeks of the rearing period (Table 7).

For all the rearing period, an interval between 39.5 and 42 ºC is reported for a comfort condition.

Table 7 - Mean values of cloacal temperature (T_{clo}) in comfort and thermal stress conditions, recommended to the six weeks of the rearing period of Avian and Cobb strains

Age (weeks)	Comfort		Stress					
			30 minutes		60 minutes		90 minutes	
	Avian	Cobb	Avian	Cobb	Avian	Cobb	Avian	Cobb
			T_{clo} (°C)					
1st	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6
2nd	41.04	41.18	41.23	41.25	41.27	41.08	40.99	41.16
3rd	41.78	41.78	43.03 - 43.16	43.03 - 43.16	43.03 - 43.16	43.03 - 43.16	43.03 - 43.16	43.03 - 43.16
4th	41.99	41.99	42.92 - 43.04	42.92 - 43.04	42.92 - 43.04	42.92 - 43.04	42.92 - 43.04	42.92 - 43.04
5th	41.89	41.89	42.29 - 42.63	42.29 - 42.63	42.29 - 42.63	42.29 - 42.63	42.29 - 42.63	42.29 - 42.63
6th	41.73	41.73	42.46 - 42.61	42.46 - 42.61	42.46 - 42.61	42.46 - 42.61	42.46 - 42.61	42.46 - 42.61

Conclusions

The Cobb strain is more tolerant to thermal stress in comparison with the Avian, once the former had minor values of physiological variables. Broilers returned to the initial pre-stress condition, and 30 minutes is enough time for birds to return to their initial condition, not necessarily a thermal equilibrium condition.

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