

Effects of Ascorbic Acid on Rectal Temperature Fluctuations in Indigenous Turkeys During the Hot-Dry Season

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Abstract: Experiments were performed on 40 indigenous turkeys with the aim of investigating, fluctuations in their Rectal Temperature (RT) and the effect of Ascorbic Acid (AA) on during the hot-dry season. Twenty turkeys which served as experimental birds were administered AA orally at the dose of 52 mg g⁻¹, while the remaining 20 turkeys which served as control were given ordinary water. Measurements of RT were taken for 3 days, one week apart, every hour from 06:00-19:00 h. The results showed that RT values in both experimental and control turkeys significantly ($p < 0.01$) fluctuated with the h of the day ($r = 0.614, 0.612$, respectively) and the dry-bulb temperature ($r = 0.794, 0.928$, respectively). The RT value of $41.2 \pm 0.03^\circ\text{C}$ recorded in experimental turkeys was significantly lower ($p < 0.05$) than the corresponding value of $41.5 \pm 0.03^\circ\text{C}$ obtained in control turkeys. The results demonstrated that AA significantly reduced RT values in experimental turkeys. In conclusion, AA administration may be of value in turkeys subjected to unavoidable stressful conditions during the hot-hours of the day.

Key words: Ascorbic acid, fluctuations, hot-dry season, rectal temperature, Turkeys

INTRODUCTION

Changes in thermal environment caused by fluctuations in Ambient Temperature (AT) and Relative Humidity (RH) induce a variety of physiological responses, which may impair functions, productivity and health of livestock (Bianca, 1976; Bazhov and Komlatsky, 1989; Ayo *et al.*, 1998). Common stress factors in modern poultry production include high AT and RH, which often occur concurrently with other stress factors, especially during the hot-dry season. The intensity and duration of the stress factors have been shown to vary with hours of the day in piglets (Fayomi *et al.*, 2004; Adenkola and Ayo, 2006) and chickens (Ayo and Sinkalu, 2003; Ayo *et al.*, 2007) and their actions on turkeys may induce heat stress, which adversely affects poultry production (Ayo *et al.*, 1996). Therefore, adequate evaluation and efficient prophylactics of the adverse effects of heat stress during the hot-dry season may be crucial to poultry productivity. It has been established that heat stress is evaluated by measuring the Rectal Temperature (RT), which is a true reflection of internal body temperature and a reliable index of thermal balance (Bianca, 1976; Mittal and Ghosh, 1979;

Ayo *et al.*, 1998). The body requirement in Ascorbic Acid or vitamin C (AA) during heat stress in poultry is greater than the amount synthesized by normal tissues and its administration may be beneficial to the body during heat stress (Sahota *et al.*, 1993; Balogun *et al.*, 1996). Also in heat stress, free radicals are generated in the body in such a large quantity that the natural antioxidant defense systems of the body are overwhelmed or exhausted (Sahin *et al.*, 2001). This results into lipid peroxidation of cytomembranes and consequently cell damage and destruction (Freeman and Crapo, 1982; Meerson, 1986; Altan *et al.*, 2003). Antioxidant supplementation (ascorbic acid) has been shown to have beneficial effects against stress-induced tissue damages (Sen, 2001; Tauler *et al.*, 2003; Ayo *et al.*, 2006; Minka and Ayo, 2007). Balogun *et al.* (1996) showed that A.A supplementation improved weight gain and feed efficiency in broiler chickens, while Minka *et al.* (2004) demonstrated the ameliorative effect of AA in pullets, subjected to road transport stress during the hot-dry season in Northern Guinea Savannah Zone of Nigeria. Data on the variation in RT of turkeys and the effect of AA on the variation during the hot-dry season in the zone are currently lacking in the available literature.

The aims of the present study were to determine the effect of AA supplementation on the RT fluctuations in turkeys during the hot-dry season in the Southern Guinea Savannah zone of Nigeria.

MATERIALS AND METHODS

The study was performed on indigenous turkeys in a poultry farm at the new government reservation area in Makurdi (07° 41' N, 08° 37' E), Benue State located in the Southern Guinea Savannah zone of Nigeria. Fourty indigenous turkeys (growers) aged 17-18 weeks and weighing between 1.8- 2.8 kg served as subjects. Twenty turkeys served as experimental while the remaining 20 served as the controls. The poultts were hatched in the farm and were accustomed to handling. Routine vaccinations against common infectious diseases at the recommended doses were carried out. During the study period, the meteorological parameters of Dry-Bulb Temperature (DBT) and RH were determined in the poultry house using dry- and wet-bulb thermometer (Brannan, England) and RH was calculated using the manufacturer's manual attached. Twelve hour prior to the commencement of the experiment, all the turkeys were deprived of water. On the experimental day at 05:50 h, the experimental turkeys were individually administered orally with AA dissolved in 10 mL of water at the dose of 52 mg kg⁻¹, while the control turkeys were individually and orally given 10 mL of sterile water. All the birds were immediately given access to water *ad libitum* throughout the experimental period. During the period all the turkeys were given feed, formulated in the farm with metabolizable energy of 2,475 kcal kg⁻¹ and crude protein of 18%, *ad libitum*. Feeds were withdrawn from the birds during the hourly RT recordings. Each turkey was restrained lightly and the recordings were completed within 15 min. Measurements of RT in turkeys were taken for 3 days, one week apart and every h from 06:00-19:00 h in February/March, using standard clinical thermometer (Hartman, digital thermometer, Germany). The RT was measured by inserting the thermometer about 3 cm, into the rectum via the cloaca until an alarm sound was produced, indicating the end of the reading. In the poultry house, dry- and wet-bulb temperatures were taken every h using a dry-and wet-bulb thermometer (Brannan, England) and concurrently with RTs of the turkeys.

Mean and standard error of the mean (Mean±S.E.M) were obtained from the values. The data were subjected to Student's *t*-test and Pearson's correlation analysis. Values of *p*<0.05 were considered significant.

RESULTS

The results are presented in Table 1-6. During the study period, the DBT was 32.0±0.2°C and the RH was 69.1±1.1% (Table 1). The mean maximum and minimum RT values in experimental turkeys were significantly (*p*<0.05) lower than the corresponding values in control turkeys. The mean hourly RT of the experimental turkeys was lowest at 06:00 h with the value of 41.0±0.0°C, while the highest value of 41.4±0.03°C was recorded at both 15:00 and 16:00 h. In control turkeys, the highest and lowest mean hourly RT values were recorded at 13:00 and 06:00 h, respectively. The values rose concurrently and significantly (*p*<0.01) with the h of the day in both experimental and control turkeys (*r* = 0.614, 0.612, respectively). The highest maximum RT value ranged between 42.0 and 42.3°C and they were recorded between

Table 1: Meteorological parameters from the study area

Hour	Relative humidity (%)	Dry-bulb temperature (°C)
06:00	77	27.4
07:00	74	27.6
08:00	77	27.7
09:00	71	29.0
10:00	65	32.5
11:00	67	32.5
12:00	67	34.7
13:00	67	34.6
14:00	67	34.5
15:00	67	35.0
16:00	67	35.5
17:00	67	34.0
18:00	67	32.7
19:00	67	32.7
Overall Mean±SEM	69.1±1.1	32.0±0.2

Table 2: Fluctuations in Rectal Temperature of Experimental Turkeys during the Hot-Dry Season (°C, n = 20)

Number	Mean±SEM	Maximum	Minimum	Range
1	41.00±0.03	41.6	40.7	0.9
2	41.07±0.03	41.5	41.0	0.5
3	40.96±0.02	41.5	40.3	1.2
4	41.38±0.03	41.8	41.2	0.6
5	41.01±0.03	41.6	40.7	0.9
6	41.03±0.05	42.0	40.7	1.3
7	41.34±0.03	41.7	40.7	1.0
8	41.29±0.03	41.7	40.4	1.3
9	41.06±0.02	41.5	40.8	0.7
10	41.09±0.04	41.5	40.7	0.8
11	41.16±0.05	42.3	40.2	2.1
12	41.01±0.03	41.3	40.2	1.1
13	41.36±0.04	42.0	40.6	1.4
14	41.03±0.03	42.0	40.1	1.9
15	41.28±0.03	41.8	40.8	1.0
16	41.21±0.03	41.6	40.7	0.9
17	41.47±0.02	41.9	41	0.9
18	41.21±0.03	41.6	40.3	1.3
19	41.29±0.03	41.7	40.7	1.0
20	41.30±0.03	42.2	40.7	1.5
Overall Mean±Sem	41.18±0.02	41.74±0.03	40.63±0.03	1.12±0.03

Table 3: Fluctuations in Rectal Temperature of Control Turkeys during the Hot-Dry Season (°C, n = 20)

Number	Mean±Sem	Maximum	Minimum	Range
1	41.82±0.04	42.3	41.0	1.3
2	41.25±0.04	41.5	40.4	1.1
3	41.37±0.03	41.8	41.0	0.8
4	41.45±0.03	41.9	41.2	0.7
5	41.58±0.02	41.8	41.3	0.5
6	41.39±0.03	41.8	41.0	0.8
7	41.74±0.03	42.8	41.3	1.0
8	41.63±0.03	42.3	41.3	1.0
9	41.40±0.03	41.7	41.0	0.7
10	41.70±0.03	42.2	41.5	0.7
11	41.58±0.04	41.7	41.0	0.7
12	41.28±0.04	41.7	40.2	1.5
13	42.05±0.04	42.5	41.6	0.9
14	41.62±0.04	42.2	41.3	0.9
15	42.46±0.03	41.9	41.2	0.7
16	41.75±0.03	42.2	41.4	0.8
17	41.27±0.03	41.7	40.8	0.9
18	41.47±0.04	41.8	40.7	1.1
19	41.43±0.05	41.7	41.0	0.7
20	41.52±0.03	41.8	41.1	0.7
Overall Mean±Sem	41.54±0.02	41.94±0.03	41.07±0.03	0.89±0.03

Table 4: Diurnal Variation in Rectal Temperature of Experimental Turkeys during the Hot-Dry Season (°C n=20)

Hour	Mean±SEM	Maximum	Minimum	Range
6:00	40.96±0.03	41.8	40.2	1.6
7:00	41.08±0.02	41.8	40.3	1.5
8:00	41.16±0.02	41.8	40.3	1.5
9:00	41.13±0.02	41.9	40.3	1.6
10:00	41.09±0.02	41.7	40.4	1.3
11:00	41.14±0.02	41.8	40.6	1.2
12:00	41.19±0.02	41.8	40.8	1.0
13:00	41.23±0.02	42.1	40.5	1.6
14:00	41.26±0.03	42.3	40.2	2.1
15:00	41.36±0.02	42.0	40.8	1.2
16:00	41.43±0.03	42.0	40.8	1.2
17:00	41.30±0.03	41.7	40.6	1.1
18:00	41.14±0.03	41.8	40.2	1.6
19:00	41.14±0.03	41.6	40.2	1.4
Overall Mean±SEM	41.19±0.03	41.86±0.03	40.44±0.04	1.42±0.04

Table 5: Diurnal Variation in Rectal Temperature of Control Turkeys during the Hot-Dry Season (°C, n=20)

Hour	Mean±SEM	Maximum	Minimum	Range
6:00	41.26±0.03	42.2	40.2	2.0
7:00	41.35±0.02	42.3	40.3	2.0
8:00	41.41±0.03	42.3	40.3	2.0
9:00	41.45±0.03	42.3	40.6	1.7
10:00	41.50±0.03	42.3	40.8	1.5
11:00	41.56±0.02	42.3	41.1	1.2
12:00	41.69±0.03	42.3	41.1	1.2
13:00	41.74±0.03	42.3	41.3	1.0
14:00	41.70±0.03	42.5	41.0	1.5
15:00	41.67±0.03	42.2	41.3	0.9
16:00	41.62±0.02	42.2	41.0	1.2
17:00	41.57±0.02	42.1	41.2	0.9
18:00	41.53±0.03	42	41.1	0.9
19:00	41.53±0.03	42	41.1	0.9
Overall Mean±Sem	41.54±0.03	42.24±0.03	40.89±0.05	1.35±0.05

13:00 and 16:00 h. The RT value of 41.3±0.03°C recorded at 06:00 h in experimental turkeys was the lowest, while the highest value of 41.7±0.33°C was obtained at 12:00

Table 6: The relationship between hours of the day, dry-bulb temperature, relative humidity and rectal temperature in turkeys during the hot-dry season

Correlated parameters	Experimental turkeys (n=20)	Control Turkeys (n = 20)
Hour of the day and rectal temperature	0.614**	0.612**
Dry-bulb temperature and rectal temperature	0.794**	0.928***
Relative humidity and rectal temperature	-0.522*	-0.790**

*p<0.05, **p<0.01, ***p<0.001

and 13:00 h. In control turkeys the highest maximum RT value of 42.5°C was recorded at 14:00 h, while the minimum RT value of 40.2°C was obtained at 06:00 h (Table 4 and 5). The highest individual mean RT value of 42.05±0.04°C was recorded in control turkey, while the highest value of 41.47±0.03°C was recorded in experimental turkey No 17. The control value was significantly higher than that of experimental turkey (p<0.05). Similarly the maximum, minimum and range RT values obtained in experimental turkeys were significantly less than (p<0.05) corresponding values in control turkeys. There was a positive correlation between the DBT and RT in experimental (p<0.01, r = 0.794) and control (p<0.01, r = 0.928) turkeys, while the relationship between RT and RH was negative and significant in both experimental and control turkeys (p<0.01, r = -0.522, -0.790, respectively) (Table 6).

DISCUSSION

The AT and RH recorded from the study period were outside the thermoneutral zone for turkeys. The results showed that RT values in both experimental and control turkeys fluctuated with the h of the day and DBT. These results were consistent with the findings of Ayo and Sinkalu (2003), Ayo *et al.* (2007) in pullets and Minka and Ayo (2007) in goats. They also supported the findings of Makarov (1989) and Piccione and Caola (2002) that such a diurnal fluctuation is driven by a biological clock, classical of most mammals. The fact that the RT value of experimental turkeys was significantly lower (p<0.05) than that of control turkeys demonstrated that AA significantly reduced the RT value in experimental turkeys. Furthermore, the peak mean RT value of 41.7±0.03°C recorded at 13:00 h was obtained two h earlier than the corresponding value of 41.4±0.02°C recorded at 15:00 h in experimental turkeys. Thus, AA did not only reduce the RT values in experimental turkeys, but also increased the time of the day at which the value was attained. The results also showed that AA prevented simultaneous rise in RT values with the peak AT values, hence ensuring the minimum effect of high AT and high

RT of the hot-dry season on the turkeys. The findings demonstrated that AA ameliorated the adverse effect of heat stress by modulating and reducing the RT values in experimental turkeys. Consequently, AA may thus maximize the productivity and health of turkeys during the hot-dry season. Although, the mechanism of action of AA was not elucidated in the present study, results obtained by Altan *et al.* (2003) showed that enormous free radicals are generated in broilers exposed to heat stress. These free radicals induce damage to cytomembranes, which may play some role in the mechanism of elevation of body temperature recorded in the control turkeys. The results obtained in the present study further confirmed the findings of Balogun *et al.* (1996), Ayo and Sinkalu (2003), Ayo *et al.* (2006, 2007) and Adenkola and Ayo (2006) that AA is a potent antioxidant in combating stress in livestock. The administration of AA to experimental turkeys in the present study strongly suggested the ability of AA to reduce cytomembrane injury induced by free radicals generated during heat stress and consequently, a reduction in body temperature of the birds. A prior AA administration may be beneficial in turkeys which are to be subjected to unavoidable stressful conditions during the hot-h of the day. It is recommended that AA be administered to turkeys during the hot-dry season prevailing in the hot-humid zones in order to reduce the adverse effects of heat stress and maximize production. The results obtained in the present study, for the first provide diurnal variation in RT of turkey, which has been lacking and demonstrated the modulating role of AA on the variation.

CONCLUSION

It is concluded that AA reduces and modulates the fluctuations in RT values in turkeys during the hot hours of the day and may be of value in combating adverse effects of stress in turkeys reared during the hot-dry season.

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