ISSN 1682-8356
ansinet.org/ijps

# INTERNATIONAL JOURNAL OF POULTRY SCIENCE

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308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

International Journal of Poultry Science 8 (5): 457-461, 2009
ISSN 1682-8356


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

A.Y. Adenkola[1] and J.O. Ayo[2]
[1]Department of Physiology and Pharmacology, College of Veterinary Medicine,
University of Agriculture, Makurdi, Nigeria
[2]Department of Physiology and Pharmacology, Faculty of Veterinary Medicine,
Ahmadu Bello University, Zaria, Nigeria

**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 $kg^{-1}$, while the remaining 20 turkeys which served as control were given ordinary water. Measurements of RT were taken for 3 days, one week apart and 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 hours 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±0.03°C recorded in experimental turkeys was significantly lower ($p<0.05$) than the corresponding value of 41.5±0.03°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, 2007; Ayo *et al*., 2007) and this 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) and this result 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). AA supplementation has been shown to improved weight gain and feed efficiency in broiler chickens (Balogun *et al*., 1996) and also in piglets (Adenkola and Anugwa, 2007) 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 twenty served as the controls. The poults 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 hours prior to the commencement of the experiment, all the turkeys were deprived of water. On the experimental day at 05:50 h, each experimental turkeys was individually and orally administered with AA dissolved in 10 mL of water at the dose of 52 mg $kg^{-1}$ by gavage and full consumption of AA was ensured, while each of the control turkeys were individually and orally given 10 mL of sterile water by the same method. All the birds were immediately given access to water *ad libitum* throughout the experimental period. During the period all the turkeys were given feed, which has metabolizable energy of 2,475 kcal $kg^{-1}$ and crude protein of 18% *ad libitum,* however 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 three days, one week apart and every hour 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 3cm, 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 hour using a dry-and wet-bulb thermometer (Brannan, England) and concurrently with RTs of the turkeys. The study period correspond to the hot-dry period in the zone.

**Statistical analysis:** 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.

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 | 0.5 |
| 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 | 40.7 | 1.3 |
| 7 | 41.34±0.03 | 41.7 | 40.7 | 1 |
| 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 | 40.6 | 1.4 |
| 14 | 41.03±0.03 | 42 | 40.1 | 1.9 |
| 15 | 41.28±0.03 | 41.8 | 40.8 | 1 |
| 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 |
| 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 | 1.3 |
| 2 | 41.25±0.04 | 41.5 | 40.4 | 1.1 |
| 3 | 41.37±0.03 | 41.8 | 41 | 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 | 0.8 |
| 7 | 41.74±0.03 | 42.8 | 41.3 | 1 |
| 8 | 41.63±0.03 | 42.3 | 41.3 | 1 |
| 9 | 41.40±0.03 | 41.7 | 41 | 0.7 |
| 10 | 41.70±0.03 | 42.2 | 41.5 | 0.7 |
| 11 | 41.58±0.04 | 41.7 | 41 | 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 | 0.7 |
| 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).

| Number | 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 |
| 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 | 40.8 | 1.2 |
| 16:00 | 41.43±0.03 | 42 | 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).

| Number | Mean ± SEM | Maximum | Minimum | Range |
|---|---|---|---|---|
| 6:00 | 41.26±0.03 | 42.2 | 40.2 | 2 |
| 7:00 | 41.35±0.02 | 42.3 | 40.3 | 2 |
| 8:00 | 41.41±0.03 | 42.3 | 40.3 | 2 |
| 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 |
| 14:00 | 41.70±0.03 | 42.5 | 41 | 1.5 |
| 15:00 | 41.67±0.03 | 42.2 | 41.3 | 0.9 |
| 16:00 | 41.62±0.02 | 42.2 | 41 | 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 |

The values rose concurrently and significantly ($p<0.01$) with the hours of the day in both experimental and control turkeys ($r = 0.614$, $0.612$, respectively). The highest maximum RT value ranged between 42.0°C and 42.3°C and they were recorded between 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 h 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 hours of the day and DBT. These results were consistent with the findings of Ayo and Sinkalu (2007), Ayo *et al.* (2007) in pullets and Minka and Ayo (2007) in goats. They also supported the findings of Marakov (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 hours 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. Although the mechanism of action of AA was not elucidated in the present study, Whitehead and Keller (2003) has shown that AA exerts hypothermic effects by potentiating gamma aminobutyric acid (GABA) a powerful inhibitory neurotransmitter in the brain. The 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 Surai (2002), Adenkola and Ayo (2006), Ayo *et al.* (2006, 2007) Ayo and Sinkalu (2007) 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-hours 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 time 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.

## REFRENCES

Adenkola, A.Y. and J.O. Ayo, 2006. Effect of ascorbic acid on diurnal variations in rectal temperature of piglets during the harmattan season. Proc. X1th Ann. Conf. Anim. Sci. Ass. Nig., 11: 9-12.

Adenkola, A.Y. and F.O.I. Anugwa, 2007. Effect of Ascorbic Acid on Performance rate of piglets in Markurdi, Benue State, Nigeria. Trop. Vet., 25: 15-17.

Altan, O., A. Pabuccuoglu, S. Konyalioglu and H. Bayracktar, 2003. Effect of heat stress on oxidative stress, lipid peroxidation and some stress parameters in broilers. Br. Poult. Sci., 44: 54-55.

Ayo, J.O., N.S. Minka and M. Mamman, 2006. Excitability scores in transported goats administered ascorbic acid during hot-dry conditions. J. Vet. Sci., 7: 127-131.

Ayo, J.O., S.B. Oladele and A. Fayomi, 1996. Heat stress and its adverse effects on livestock production: A review. Nig. Vet. J. (Sp Ed), 1: 58-68.

Ayo, J.O., O.O. Owoyele and T. Dzenda, 2007. Effect of ascorbic acid on diurnal variations in rectal temperature of Bovan Nera pullets during the harmattan season. Int. J. Poult. Sci., 6: 612-616.

Ayo, J.O. and V.O. Sinkalu, 2007. Effect of ascorbic acid on diurnal variations in rectal temperature of Shaver brown pullets during the hot-dry season. Int. J. Poult. Sci., 6: 642-646.

Ayo, J.O., S.B. Oladele, A. Fayomi, S.D. Jumbo and J.O. Hambolu, 1998. Body temperature, respiration and heart rate in Red Sokoto goat during harmattan season. Bull. Anim. Hlth. Prod. Afr., 46: 161-166.

Balogun, T.F., S.B. Afolayan, P.C. Njoku and I.I. Dafwang, 1996. Effect of ascorbic acid (vitamin C) and acetysalycilic acid (aspirin) supplementation of broiler diets on performance during the hot season. Samaru J. Agric. Edu., 5: 80-86.

Bazhov, G..M. and V.I. Komlatsky, 1989. Biotechnology of Intensive Swine Production. Rosagropromizdat, Moscow, (in Russian), pp: 269.

Bianca, W.K., 1976. The significance of meteorology in animal production. Int. J. Biometeorol., 20: 139-156.

Fayomi, A., J.O. Ayo and A.O. Akinpelu, 2004. Effect of ascorbic acid on diurnal variations in rectal temperature of piglets during the hot-dry season. Proc. 28th Ann. Conf. Nig. Soc. Anim Prod., 29: 104-107.

Freeman, B.A. and J.D. Crapo, 1982. Biology of diseases: Free radical and tissue injury. Lab Invest., 47: 412-426.

Marakov, V.I., 1989. Changes in biorhythms in external conditions. In: Chronobiology and Chronomedicine. Meditsina Publishing House, Moscow (in Russian), pp: 169-183.

Minka, N.S. and J.O. Ayo, 2007. Physiological responses of transported goats treated with ascorbic acid during the hot-dry season. Anim. Sci. J., 78: 164-172.

Minka, N.S., A. Fayomi and J.O. Ayo, 2004. Effect of road transportation and ascorbic acid on haematological parameters of pullets during the hot-dry season. Proc 38th Ann. Conf. Agric. Soc. Nig., pp: 653-659.

Mittal, J.P. and P.K. Ghosh, 1979. Body temperature, respiration and pulse rate in Corriedale, Marwari and Magra Sheep in the Rajasthan desert. J. Agric. Sci. (Cambridge), 95: 587-591.

Meerson, F.Z., 1986. The general mechanism and role of stress responses in adaptation. Major stages in adaptation process. In: Physiology of Adaptation Processes. Nauka Publishing House, Moscow, (in Russian), pp: 77-123.

Piccione, G. and G. Caola, 2002. Biological rhythm in livestock. J. Vet. Sc., 3: 145-157.

Sahin, K., N. Sahin, M. Onderci, S. Yaraliogu and O. Kucuk, 2001. Protective role of supplemental vitamin E on lipid peroxidation, vitamins E, A and some mineral concentrations of broilers reared under heat stress. Vet. Med. (Czechoslosvakia), 46: 140-144.

Sahota, A.W., M.F. Ulah, A.H. Gilani and M.D. Ahmad, 1993. Effect of vitamin C supplementation the performance of Lyallpur Silver Black and White Leghorn chicks exposed to heat stress. Pak. Vet. J., 12: 28-31.

Sen, C.K., 2001. Antioxidant in exercise. Nutr. Sports and Med., 31: 891-908.

Surai, P.F., 2002. Selenium in poultry nutrition 1. Antioxidant properties, deficiency aaand toxicity. World's Poult. Sci. J., 58: 333-347.

Tauler, P., A. Aquilo, I. Gimeno, E. Fuentespina, J.A. Tur and A. Pons, 2003. Influence of Vitamin C diet supplementation on endogenous antioxidant defense during exhaustive exercise. Eur. J. Physiol., 446: 658-664.

Whitehead, C.C. and T. Keller, 2003. An update on ascorbic acid in poultry (Reviews). World's Poult. Sci. Assoc., 59: 161-184.