ON-BOARD THERMAL LOAD AND THE EFFECTS OF α-TOCOPHEROL AND ASCORBIC ACID ON COLONIC TEMPERATURE OF TRANSPORTED QUAILS (*Coturnix coturnix Japonica*)

N.S. MINKA[a,*] and J.O. AYO[b]

*[a]College of Agriculture and Animal Science, P.M.B. 2134. Division of Agricultural Colleges, Ahmadu Bello University, Mando – Kaduna, Nigeria, [b]Department of Physiology, Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria, Nigeria, *Correspondence: N. S. Minka. E-mail: mnsalka@yahoo.comTel: +2348036527538*

ABSTRACT

This study investigated on-board thermal load and the effects of antioxidants vitamin E (VE, α-tocopherol) and ascorbic acid (AA) on colonic temperature (CT) of 80 male Japanese quails transported by road for 2 h. The birds were divided into 4 groups: VE- and AA-treated groups, administered with 60 mg/kg and 200 mg/kg body weight, respectively, of VE and AA, control transported group, administered with 0.5 ml of sterile water, and sedentary non-transported group. Shortly after the administration of the antioxidants, the birds were transported by road for 2 h. The CT of the birds was recorded before, during and immediately after transportation and on the third day of post-transportation period. On-board thermal load inside the vehicle was assessed using the enthalpy comfort index (ECI) which measured the amount of heat in kcal, contained in 1 kg of dry air. The ECI inside the vehicle during transportation fluctuated between 90 - 110 KJ/Kg. The CT recorded during transportation in the control quails were significantly ($P < 0.05$) higher than the values recorded in VE and AA treated birds. Immediately after transportation, the CT was significantly ($P<0.05$) lower in VE (40.1 ± 0.2^0C) birds compared to the values obtained in AA (41.3 ± 0.6^0C) treated, control (42.5 ± 0.4^0C) and sedentary (40.8 ± 0.4^0C) quails, respectively. Mortality was not recorded during transportation. In conclusion, 2 h of road transportation induced hyperthermia and high thermal load, the effects of which were ameliorated by VE and AA. The ameliorating effect was more pronounced in quails administered with VE.

INTRODUCTION

Transportation of birds by road can have adverse effect on their welfare, especially when transported during the hot-dry conditions. Thus, the whole process of transportation can result in severe stress and is manifested first, by increase in body temperature. Inspite of the increasing demand for quails worldwide as laboratory and farm birds, the response and tolerance of the body temperature of quails to road transportation under unfavourable environmental conditions are poorly studied (Tekelioglu *et al*., 2010; Minka and Ayo, 2011; Gonzalez *et al*., 2007). Besides, there is little information on the ameliorating effects of antioxidant vitamins on thermoregulatory responses of quails to stress due to road transportation. In addition, there is paucity of information that quantifies the amount of thermal load experienced by quails during road transportation. Several studies have reported the use of analgesics, neuroleptics, electrolytes, pro- and prebiotics, and ascorbic acid to remediate the adverse effects of thermal and road transportation stress in animals, including birds (Ali *et al*., 2006; Minka and Ayo, 2011). Antioxidants VE and AA are known to play a major role in ameliorating the negative effects of stress and diseases in both humans and animals (Tauler *et al*., 2003; Manjula *et al*., 2013). There use as agents for modulating thermoregulation may add to the data of ongoing research on transportation stress. Body temperature measurement is an ideal indicator for the assessment of stress and adaptability of livestock, including poultry, to various environmental stress factors (Minka and Ayo, 2008). Enthalpy comfort index is an index of thermal comfort which expresses the amount of heat in kcal, contained in 1 kg of dry air (Barbosa, 2005). The calculation of enthalpy is directly related to AT and RH. These two variables inform the conditions that favour or hinder the heat loss by birds in transported vehicles (Rodrigues *et al*., 2010; Barbosa *et al*., 2014). To date there is a paucity of information in quantifying thermal load experience by quails during road transportation. The present study was aimed at assessing the ECI and the effects of VE and AA on thermoregulation of transported Japanese broiler quails during the hot-dry conditions.

MATERIALS AND METHODS

The experiment was performed at the Livestock Farm of the College of Agriculture and Animal Science, Ahmadu Bello University, Kaduna (11°

10′N, 07° 38′E), Nigeria. The ambient temperature (AT), relative humidity (RH) and CT were recorded at the experimental site at 07:00 h, 13:00 h and 18:00 h daily for 3 consecutive days before and after transportation. Values of these parameters were also recorded at 30 min, 1 h and 2 h of the transportation period. The AT and RH were measured using a wet- and dry-bulb thermometer (DTH 1, Clarke Int. Epping, Essex, UK). The ECI which expresses the amount of heat in 1kg of dry air, in KJ was determined by a formula that integrated the AT and RH recorded during the transportation (Barbosa, 2005; Rodrigues *et al.*, 2010; Barbosa *et al.*, 2014). The CT measurement was done using a digital clinical thermometer (Cocet, Shenzhen, Guangdong, China), inserted about 2-3 cm into the cloacae through the anus till an alarm sound was heard, indicating the end of the reading. Baseline CT was obtained in 20 quails, selected at random for each period of measurement before the transportation day. Eighty 8-week-old Japanese male quails, weighing 189.0 ± 2.5 g on average served as subjects. On transportation day, 30 min to one hour before loading into a vehicle, the birds were divided into 4 groups of 20 birds each: VE- and AA-treated groups, administered with 60mg/kg and 200 mg/kg body weight, respectively, control transported group, administered with 0.5 ml of sterile water, and sedentary non-transported group. The birds in each group were colour-marked for easy identification. Feed and water were withdrawn from the birds 6 h before transportation. The CTs of the birds were recorded before transportation, immediately after transportation and on the third day of post-transportation period. The transported birds were loaded in 4 standard quail crates at a stocking density of 130 cm^2/bird (Abdel-Azeem, 2011). Each crate of the transported group contained 20 birds. The crates were then loaded to a Golf-wagon vehicle and transported for 2 h. The journey started by 11:00 h and was terminated at 13:00 h. The vehicle travelled with an average speed of 50-70 km/h for 2 h on a typical asphalt single-lane road, from Kaduna (11° 10′N, 07° 38′E) to Birnin Gwari and from Birnin Gwari back to Kaduna, covering a total distance of about 120 km. After the transportation, the birds were returned to the same place and managed as it was done before transportation. Data obtained were subjected to Student's *t*-test and presented as mean ± standard error of the mean. $P < 0.05$ were considered significant.

RESULTS AND DISCUSSION

The ECI recorded inside the vehicle fluctuated between 90 and 110 KJ/Kg (Table 1). As a comfort index, ECI indicates environmental conditions related to heat stress suffered by birds. Although there are no reports on the recommended ECI in transported quails, studies on broilers showed that ECI of 54-68 KJ/kg of dry air is acceptable during transportation, while ECI values of 69-75.8 KJ/kg and 75.9-90.8 KJ/kg are termed critical and lethal, respectively, and are associated with higher mortality as compared with ECI of 54-68 KJ/kg (Barbosa *et al.*, 2014). In the present study, the high values of ECI recorded inside the crates suggested that the micro-environment was not comfortable for the birds, and they may, thus, suffer heat stress. The result that no mortality was recorded in the present study at ECI above 100 KJ/kg, inspite of the fact that these values were reported to be critical and lethal, suggested that the quails were able to withstand heat stress better than the broilers. More studies to establish ECI for quails are required. Results of ECI during transportation can be obtained automatically using a data-logger fitted inside the vehicle (Barbosa, 2005) and the information obtained could suggest the need to adjust transportation conditions by adjusting ventilation, wetting of birds or all together suspend the journey. The CT values recorded in control quails at 30 minutes, one hour and two hours of the transportation period were significantly higher ($P < 0.05$) than the corresponding values recorded in VE and AA-treated and sedentary quails (Table 1). The mean CT value of 40.1 ± 0.2°C recorded after transportation in VE quails was significantly lower ($P < 0.05$) than the corresponding values of 41.3 ± 0.6°C, 42.5 ± 0.4°C and 40.8 ± 0.4°C, recorded in AA, control and sedentary quails, respectively. Three days after transportation the CT of the birds in all the groups returned to baseline values. The adverse effect of the 2 h of road transportation on thermoregulation of the quails was demonstrated by a significant increase in CT of the control quails above normal values. The present result agreed with that of González *et al* (2007), but disagreed with that obtained by Tekelioglu *et al* (2010); although CT was not measured in his study, Tekelioglu *et al* (2010) showed that 2 h of simulated transportation did not induce any stress in the quails. The difference in the finding may be due to the fact that his study was a simulation and the quails used were transported under thermoneutral AT of

18^0C. Such low AT is not attainable under normal (natural) transportation conditions in tropics during the hot-dry season. In general, poultry face difficulties in maintaining body temperature, especially under high ambient temperature, apparently due to lack of sweat glands and relatively high body temperature (Donkoh, 1989). The significantly lower CT values obtained in VE and AA quails during and after the transportation demonstrated the ameliorating effects of these antioxidants on thermal load and CT of quails, subjected to road transportation stress under high ECI. Several reports have demonstrated the efficiency of these antioxidants against various stress factors (Sahin *et al.*, 2004; Tauler *et al.*, 2003; Manjula *et al.*, 2013). The antioxidant effect was more pronounced in VE quails as compared to AA quails, apparently, due to the fact that VE is lipid soluble, thus, it served as a lipophilic free-radical scavenger, mainly localised in phospholipid bilayer membranes (Altan *et al.*, 2003). This property of VE may contribute to its high efficacy in reducing CT of the quails than AA, which is solely water-soluble and acts primarily in cellular fluid. Lipid peroxidations have been proven to be major contributory factors that increase oxidative stress and body temperature (Altan *et al.*, 2003). This requires further investigation.

Conclusions

In conclusion, 2 h of road transportation induced hyperthermia and thermal load, the effects of which were ameliorated by VE and AA. The ameliorating effect was more pronounced in quails administered with VE.

Acknowledgements

The authors are grateful to the Laboratory staff of the College of Agriculture and Animal Science, Kaduna.

REFERENCES

Abdel-Azeem, F.A. (2010). The influence of different stocking density and sex on productive performance and some physiological traits of Japanese quail. *Egypt. Poult. Sci.* 30 (1): 203-227.

Ali, B., Al-qarawi, A., Mousa, H. (2006). Stress associated with road transportation in desert sheep and goats and the effect of pretreatment with xylazine or sodium betaine. *Res. Vet. Sci.* 80: 343-348.

Altan, O., Pabuccuoglu,. A, Konyaliogu, S., Bayraktar, H. (2003). Effects of heat stress on oxidative stress, lipid peroxidation and some stress parameters in broilers. *Br. Poult. Sci.* 44:545–550.

Barbosa F.A.D. (2005). Welfare evaluation by image analysis of laying hens in different houses systems and environmental conditions. 2005. 123 p. Dissertation (MSc in Physics of Agricultural Environment) - Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo, Piracicaba.

Barbosa F.A.D., Queiroz, M.L.V., Brasil, D.D.F., Vieira, F.M.C., Silva, I.J.O. (2014). Transport of broilers: load microclimate during brazilian summer. *Eng. Agríc., Jaboticabal.* 34: 405-412

Donkoh, A. (1989). Ambient temperature: A factor affecting performance and physiological response of broiler chickens. *Int. J. Biometeorol.* 33:259-265.

González, V.A., Rojas, G.E., Aguilera, A.E., Flores-Peinado, S.C., Lemus-Flores, C., Olmos-Hernández, et al. (2007). Effect of heat stress during transport and rest before slaughter on the metabolic profile, blood gases and meat quality of quail. *Int. J. Poult. Sci.* 6(6):397-402.

Manjula, K.R., Subramanyam, M.V., Asha, D.S. (2013). Protection against oxidative stress caused by intermittent cold exposure by combined supplementation with vitamin E and C in the aging rat hypothalamus. *Neurochem. Res.* 38(4):876-85.

Minka, N.S., Ayo, J.O. (2011). Modulating role of vitamins C and E against transport-induced stress in pullets during the hot-dry conditions. *ISRN Vet. Sci.* Doi:10.5402/2011/497138.

Minka, N.S., Ayo, J.O. (2008). Haematology and behaviour of pullets transported by road and administered with ascorbic acid during the hot-dry season. *Res. Vet. Sci.* 85:387-393.

Rodrigues V.A., Oliveira da Silva, J.O., Vieira, F.M.C., Nascimento, S.T. (2010). A correct enthalpy relationship as thermal comfort index for livestock. *Int. J. Biometeorol.* DOI 10.1007/s00484-010-0344-y.

Sahin, N., Onderci, M., Sahin, K., Gursu, M.F., Smith, M.O. (2004). Ascorbic acid and melatonin reduce heat-induced performance inhibition and oxidative stress in Japanese quails. *Br. Poult. Sci.* 45:116-122.

Tauler, P., Aguilo, A., Gimenó, I., Fuentespina, E., Tur, J.A., Pons, A. (2003). Influence of vitamin C supplementation on endogenous antioxidant defense during exhaustive exercise. *Eur. J. Physiol.* 440:658-664.

Tekelioglu, O., Sezer, M., Ekici, F., Atis, O., Akbas, A. (2010). The effect of simulated transportation on biochemical plasma parameters of Japanese quails. *J. Anim. Vet. Advances* 9:892-895.

Table 1: Fluctuations in enthalpy comfort index inside the vehicle and colonic temperature responses of the quails during transportation period.

		Colonic temperature (^0C)			
Transportation period	Enthalpy comfort index (KJ/Kg)	Control (n = 20)	α-Tocopherol (n=20)	Ascorbic acid (n=20)	Sedentary (n=20)
30 min	90.5	42.8± 0.2	40.8± 0.1	41.8± 0.4	40.9± 0.5
1 hour	108.4	42.4± 0.5	39.8± 0.2	41.2± 0.1	41.0± 0.2
2 hours	110.6	42.5± 0.2	39.7± 0.3	40.9± 0.8	40.5± 0.1
Mean±SEM	103.3 ± 5.4	42.5 ± 0.4^a	40.1 ± 0.2^b	41.3 ± 0.6^c	40.8 ± 0.4^b

Overall mean colonic temperature values with different superscript alphabets along the same row are significantly difference ($P < 0.05$).