MODULATORY EFFECT OF ASCORBIC ACID ON HEART RATE RESPONSES OF DONKEYS TO PACKING DURING THE HARMATTAN SEASON

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ABSTRACT

The aim of the study was to determine the heart rate responses of packed donkeys adminstered with ascorbic acid during the harmattan season. Six donkeys administered orally with ascorbic acid (200 mg/kg), dissolved in distilled water, and subjected to packing served as experimental animals; while six others, administered with distilled water only, served as controls. The heart rate (HR) of each donkey was recorded at 6:00 h pre-packing, and 30 min, 2 h and 4 h post-packing. The HR values recorded 30 min post-packing in control donkeys (75.88 ± 4.49 beats/min) were higher ($P < 0.05$) than the value of 59.25 ± 3.97 beats/min obtained in experimental donkeys. The HR values obtained 2 h post-packing in both control (64.21 ± 1.34 beats/min) and experimental donkeys (58.00 ± 1.73 beats/min) were not significantly ($P > 0.05$) different from that recorded 30 min post- packing. In conclusion, administration of ascorbic acid pre-packing alleviated the adverse effects of work stress in donkeys during the harmattan season.

Key Words: Heart rate, ascorbic acid, donkey, harmattan.

INTRODUCTION

The role of donkeys in rural areas have received increasing attention from researchers (Pearson, 2003; Minka and Ayo, 2007; Ayo *et al.*, 2014). Donkeys are majorly used for transportation of goods like firewood, sand and water (Ayo *et al.*, 2008). Increase in physiological parameters above normal range in donkeys indicates that they are stressed (Pal *et al.*, 2002).The heart rate (HR) as a physiologic parameter is an important index of health status (Dey *et al.*, 2010; Wojtas *et al.*, 2014). This parameter is useful in the investigation of adaptation and tolerance of animals to environmental stress (McManus *et al.*, 2014). The harmattan season has been observed to be stressful in the Northern Guinea Savannah zone of Nigeria (Minka and Ayo, 2014). It is characterized by low dry-bulb temperatures (DBTs) during the morning and late evening hours, but very high DBT during the morning hours (Dzenda *et al.*, 2011). Stress has been shown to induce the generation of reactive oxygen species, which may be scavenged by potent low molecular antioxidants amongst which is vitamin C, otherwise known as ascorbic acid (AA) (Lushchak, 2014).There is paucity of information on the role of AA in donkeys subjected to packing during the thermally stressful harmattan season of the Northern Guinea Savannah zone of Nigeria. The aim of the study was to determine the heart rate responses of packed donkeys adminstered with AA during the harmattan season.

MATERIALS AND METHODS

Study Area

The donkeys were trekked to cover a distance from Ahmadu Bello University (ABU), Zaria (11°10′N, 7°38′E) to Panhauya village (11°7′N, 7°37′E) in the Northern Guinea Savannah zone of Nigeria. The road was narrow with rocky and stony terrain, typical of the route taken by donkeys in the zone.

Animals and Management

Twelve, apparently, healthy pack donkeys between 3-4 years, comprising six males and six females, served as experimental subjects. The donkeys were purchased from donkey market at Sheme, about 10 km from Faskari (11° 43′ N, 7° 02′E), Katsina State, Nigeria. They were divided into two groups and pre-conditioned for two weeks, during which they were screened and treated for ecto- and endoparasites. The donkeys were fed with guinea corn straw and groundnut hay in the proportion of 4:1 and supplemented with wheat bran. In addition, 1 kg of whole sorghum grain was fed to each donkey per day throughout the experimental period. The donkeys were given free access to water during the experimental period and salt licks were provided.

Measurement of Thermal Environmental Parameters and Heart Rate

The pre-packing and post-packing values of HR were taken concurrently with DBT and RH using a wet- and dry-bulb thermometer at the experimental site (Brannan, England), and RH was determined using a centigrade scale (Centigrade Table of Relative Humidity or

Percent Saturation, New York: Product Testing and Services Inc., 110 Colin Drive, Holbrook, New York, 11741, www.nypts.com). Temperature-humidity index (THI) was calculated (Yousef, 1985).

$THI = (0.35\ t_d + 0.65\ t_{wb}) \times 1.8 + 32$

Where, t_d = dry bulb temperature (°C), t_{wb} = wet-bulb temperature (°C)

The pre-packing and post-packing values of HR were recorded daily from each donkey using a standard method (Ayo *et al.*, 2008). The pre-packing values of HR were recorded at 06:00 h, while those of post-packing were obtained 30 min, 2 h and 4 h after completion of the work.

Administration of Ascorbic Acid

The experimental animals (n = 6) were administered with AA (L-ascorbic acid; Sigma Chemical, St. Louis, Mo, U.S.A.) orally and individually at 200 mg/kg (Chervyakov *et al.*, 1977), dissolved in 20 ml of sterile water. The control animals (n = 6) were given 20 ml of sterile water only. AA was administered 30 min before packing the donkeys on each day of the experiment.

Packing Procedure

All the donkeys were saddled at 07:00 h with a locally-made leather saddle pack frame, checked with chopped dry grasses to provide a cushion effect on the back of the animals. Each donkey was subjected to work by packing it with sand, at the loading rate of 50% of the body weight (Pal *et al.*, 2002) every morning on each experimental day. The donkeys were subjected to work for three days for 4 h, from 10:00 h to 14:00 h.

Statistical Analysis

The data obtained were expressed as mean ± standard error of the mean (Mean ± SEM) and subjected to one-way analysis of variance (ANOVA), followed by Tukey's *post-hoc* test, using GraphPad Prism 4.0 for Windows (GraphPad Software, San Diego Carlifonia, USA) to compare differences between the means obtained from the control and experimental donkeys. Values of $P < 0.05$ were considered significant.

RESULTS AND DISCUSSION

The overall mean value of DBT recorded during the experiment was 26.38 ± 2.96 °C, while the RH was 22.67 ± 5.0 % (Table 1). The results showed that the harmattan season had mostly low RH and high DBT, typical of the season. THI rose to as the hour of the day increased to 83.43 ± 6.8 at 14:30 h, indicating that the donkeys experienced thermal discomfort at this point since the value exceeded the normal comfortable THI value of 80 for donkeys (Yousef, 1985). Figure 1 shows the HR responses of donkeys to packing. The control donkeys had significantly ($P < 0.05$) higher heart rate values of 75.67 ± 1.45 beats per minute and 64.21 ± 1.34 beats per minute at 30 min and 2:00 h post-packing, respectively than corresponding values of 61.11 ± 0.91 beats per minute and 58 ± 1.73 beats per minute, respectively, recorded in the experimental donkeys. The values of HR in both control and experimental donkeys 4 h post-packing were 54.23 ± 4.71 beats per minute and 56.88 ± 2.45 beats per minute, respectively ($P > 0.05$). The donkeys responded to the high THI by significantly increasing their heart rate which agrees with previous findings (Ayo *et al.*, 2008; 2014) that HR increases in donkeys exposed to high environmental temperatures. However, the magnitude of this increase was significantly higher in the control than in experimental donkeys. The rise in HR apparently, increased blood flow from the core to the surface to allow heat loss by sensible (conduction, convection and radiation) and insensible (diffusion from skin) means (Alexiev *et al.*, 2004). In the experimental donkeys, AA, as a potent antioxidant, may ameliorate adverse effects of stress due to packing during the harmattan season established to be thermally stressful to livestock, by stabilizing blood flow and depressing the central nervous system. The increase in HR observed 30 min post-packing may be a compensatory mechanism by which donkeys maintain homeostasis in response to high THI, albeit the experimental animals adapted better and recovered faster than controls.

CONCLUSION

AA may be used by local donkey owners to ameliorate the adverse effects of work stress in donkeys subjected to packing.

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Table 1: Thermal Environment Conditions of the Study Period (Mean ± SEM)

Period	Time	Dry-bulb temperature (°C)	Relative humidity (%)	Temperature-humidity index
Pre-packing:	6: 00 h	13.67 ± 1.30	20.67 ± 3.33	46.46 ± 2.01
Post-packing:	30 min	36.50 ± 5.22	41.67 ± 16.80	83.43, ± 6.87
	2 h	28.83 ± 4.66	13.33 ± 3.83	77.93 ± 2.36
	4 h	26.50 ± 2.59	15.00 ± 2.08	64.19 ± 5.81
Overall Mean ±SEM		26.38 ± 2.96	22.67 ± 5.07	68.35 ± 6.78

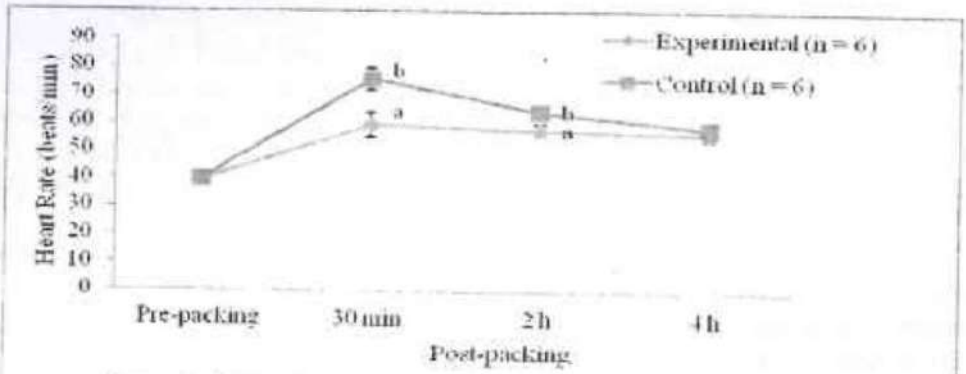

Figure 1: Effect of ascorbic acid on heart rate of packed donkeys. Values are means ± SEM.

a,b = Values with error bars having different superscripts are significantly (P < 0.05) different