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Excitability scores of goats administered ascorbic acid and transported during hot-dry conditions

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In this study, we investigated the effect of ascorbic acid (AA) administration on goat excitability due to transportation. Ten goats administered AA (p.o.) at 100 mg/kg of body weight before transportation served as the experimental group, and seven goats administered only 10 ml/kg of sterile water (p.o.) served as controls. Excitability scores were recorded for each goat; when weighed, before, immediately after, and 3 h after 8 h of transportation. A score of one to four was allocated to each goat; higher scores represent greater excitability. Immediately after transportation, excitability scores decreased significantly, especially those of control goats ($p < 0.001$). At 3 h post-transportation, the excitability scores of animals in the experimental group were not significantly ($p > 0.05$) different from their pre-transportation normal values, whereas those of control goats were significantly lower ($p < 0.01$). The correlation i.e. the relationship between excitability score values and percent excitability (percentage of goat with particular excitability score) for different excitability score group 3 h post-transportation was positive and highly significant ($p < 0.001$), in both experimental and control goats. Our results indicate that road transportation induces considerable stress (depression) in goats as evidenced by a lower excitability score post-transportation. Moreover, the administration of AA pre-transportation facilitated the transition from a state of depression to excitation. In conclusion, AA administration to animals prior to transportation may ameliorate the depression often encountered after road transportation.

Key words: ascorbic acid, excitability score, goat, transportation

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Introduction

The transportation of food animals is an inevitable husbandry practice which animals unexpectedly encounter, especially those reared predominantly under traditional extensive management systems. The stress factors acting upon domestic animals during their transportation, especially during hot conditions can induce physical and psychic exertions, which disrupt homeostasis, and consequently the metabolism [20,9].

The behavioral responses of livestock during transportation are diverse and most are dependent on stimuli received. Greatest stress is induced by handling and the start of a journey, which activate the sympathetic nervous system, including the adrenal medulla and eventually the adrenal cortex [10,11]. Behavioral changes are often the first and primary sign of distress [3]. Moreover, the establishment of a new hierarchical order in the new environment in which goats find themselves during the transportation period aggravates behavioral patterns. This is because strong animals, especially males, try to occupy the best place in the vehicle, which leads to aggression and fighting [15]. In addition, the excitability of goats depends on animal temperament, which is a trait that seems to be stable over time [10].

The behavior of goats during transportation has received limited attention, but is becoming a major concern to animal welfarists and to those in the business of goat marketing. It has been shown that behavioral indicators of discomfort during transportation are; freezing, back off, attempts to escape, vocalization, kicking, and struggling [5]. The understanding of the behavior of transported farm animals may be of value during the development of management strategies aimed at increasing productivity [21].

Vitamin-C, otherwise known as ascorbic acid (AA), is a potent antioxidant, and has been demonstrated to control mood and brain functions, and to ameliorate heat stress and the adverse effects of environmental conditions. AA can also be tolerated at high doses without apparent side effects [12,4].

The present study was to investigate the excitability of goats transported by road during hot-dry conditions and to determine the effects of vitamin C or ascorbic acid (AA) on excitability.

Materials and Methods

Description of experimental site

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), located in the Northern Guinea Savannah zone of Nigeria. Goats were transported between Kaduna and Birnin-Gwari (10° 39' N, 6° 33' E) and back to Kaduna (300 km) during the late hot-dry season during May, 2005. This region is characterized by intensive marketing, and consequently livestock transportation, especially during the late hot-dry and early rainy seasons, when farmers prepare for planting. Many farmers in the region practice mixed farming, and sell their goats at the onset of the rainy season to generate funds for purchases and for paying salaries on crop farms.

Meteorological data

Dry-bulb temperature (DBT), relative humidity (RH), and wind direction were recorded at experimental sites at 06 : 00, 13 : 00, and at 18 : 00 h daily for seven consecutive days before and after transportation. Values of these parameters were also recorded at 1, 2, 4, 6 and 8 h in the journey, and after unloading goats from the vehicle at 1, 2 and 3 h post-transportation. A dry and wet bulb thermometer (Cocet, China) was used to measure temperatures.

Animals and management

Seventeen healthy Red Sokoto goats, including males and non-pregnant females of about 2-3 years old and weighing 17-20 kg, served as the experimental subjects.

The goats were purchased from Mando, a village located 1 km from the experimental site in Kaduna, 3 weeks before the day of the experiment. Animals were kept in a communal pen, with a concrete floor and cement block walls with asbestos roofing. The pen was 6 m long by 4 m wide and 2.5 m high, and the top half of one side was open, which provided adequate ventilation. The goats were not restrained inside the pen. They were fed with groundnut hay, maize offal, whole grain guinea corn, and water was provided *ad libitum*. Occasionally, salt lick was provided.

The goats were preconditioned for 2 weeks before commencing the experiment. During this period, they were screened for diseases and prophylactically treated against haemoprotozoal diseases with diminazine aceturate (Nozomil; Kepro B.V., Holland) at a dose of 3.5 mg/kg of body weight by deep intramuscular injection. The goats were also dewormed with morantel tartrate (Banminth F; Pfizer, USA) orally, at a dose of 0.8 g/kg. The pen was kept clean.

Experimental design

Food and water were withdrawn 12 h before the journey and throughout the journey period, which lasted 8 h. Ten of the experimental goats were orally administered AA (Michelle Laboratories, Nigeria) at 100 mg/kg body weight, dissolved in 10 ml of sterile water. Seven goats in the control group were each given 10 ml of sterile water only. These administrations were made immediately before loading the goats into the vehicle. The vehicle traveled on tarred roads from Kaduna to Birnin-Gwari and back to Kaduna, covering a total distance of about 300 km at a speed range of 40~50 km/h. The duration of the journey was 8 h, and including stop-overs to measure meteorological data and for police checking. After completing the journey, the goats were unloaded at the original loaded point. The animals were fed and watered as they had been immediately prior to the journey.

Vehicle design, loading, and journey time

A standard Bedford, pick-up van made in England and popularly used in the Guinea Savannah zone of Nigeria, was used to transport the animals. The floor of the vehicle was made of thick wooden planks, and the inner compartment measured 5.5 m × 1.5 m × 1.5 m high. The sidewalls of the vehicle from the floor to a height of 0.6 m were completely covered with corrugated aluminum, but the remainder was composed of woven interrupted aluminum rods, which provided a rigid support. A door was provided at the rear end. The vehicle had no roof, a characteristic of most vehicles used for goat transportation in the region. Other transportation procedures were carried out in accordance with our national guidelines governing the welfare of animals during road transportation [17]. Briefly, the floor of the vehicle was covered with wood shavings. Two persons loaded the goats into the vehicle. Under relatively calm conditions, one person caught a goat and led it to the other person, already inside the vehicle who in turn restrained the goat to the body of the vehicle, using a sisal rope half meter long tied to the neck loop of each goat. The goats were stocked at a stocking rate of 0.3 m^2 per animal. They were made to stand inside the vehicle in two rows facing toward the rear of the vehicle. The journey commenced at 7 : 00 am.

Measurement of excitability scores

Excitability scores were recorded when goats were weighed, before loading into the vehicle, immediately after unloading, and 3 h after unloading. Excitability scores were measured as earlier described [15,24]. Briefly, during the handling of a goat while weighing (Philip Harris, UK), a score of one to four was allocated to each goat by a single observer; a higher score representing a greater level of excitability. A score of one was allocated to a goat that was calm, and made little movement during the handling, two was allocated to an animal that occasionally shook itself in

an attempt to escape, three was assigned when the animal continuously attempted to free itself, and shook the balance, and a score of four was given when a goat struggled violently throughout the entire weighing period.

Statistical analysis

All data obtained were subjected to the Student's t-test and correlation analysis. Data are expressed as mean ± SE. The p values of < 0.05 were considered significant. Excitability scores for each period were summed and results are presented as percentiles.

Results

Meteorological data

Ambient temperatures recorded during the study period at the experimental site ranged between 37°C and 21°C (max/min), a wide diurnal range of 16°C. Mean ambient temperatures outside and inside the pen were 31.7 ± 2.6°C and 27.5 ± 1.4°C, respectively. RH during the experimental period ranged between 82~91%, and the RH inside the pen was higher ($p < 0.05$) than that outside (88.0 ± 2.1% and 83.0 ± 0.6%, respectively). Wind direction was predominantly south-west, and there was no rainfall during the study period. DBTs were highest at 13 : 00 h both inside and outside the pen, at 30.5 ± 0.1°C and 37.2 ± 0.8°C, respectively.

During the journey DBTs rose gradually from 22.0°C during the 1st hour of the journey, and attained a peak value of 37.5°C during the 6th hour of transportation at 14 : 00 h. (Table 1). This value was maintained up to the eighth hour of transportation, when the journey was completed. The mean DBT prevailing during the journey inside the truck was 31.8 ± 2.6°C, whereas RH ranged between 51- 90% with a mean of 65.2 ± 6.4%. Thus, RH varied by 39% during the journey period (Table 1).

Meteorological data during the post-transportation study period showed mean ambient temperatures of 32.0 ± 2.6°C outside and 28.0 ± 1.4°C inside the pen, while mean RH values outside and inside the pen were 78.3 ± 2.1 and 83.7 ± 2.8%, respectively. Meteorological data during the post-transportation study period was similar to that during the pre-transportation period ($p > 0.05$).

Table 1. Ambient temperature and relative humidity inside the vehicle during the journey period

Hour of journey	Dry-bulb (°C)	Relative humidity (%)
1	22.0	90
2	29.5	61
4	32.5	51
6	37.5	53
8	37.5	71
Mean ± SE	31.8 ± 2.6	65.2 ± 6.4

Percent excitability score

The result of the excitability scores in both experimental and control goats pre-transportation were shown in Fig. 1. An excitability score of four was recorded for 52.0 ± 8.8% of experimental group animals and for 45.5 ± 12.4% of the controls, respectively. No excitability score of one was recorded. Results were similar for controls ($p > 0.05$).

Although no goat had an excitability score of one pre-transportation, immediately after transportation 27.5 ± 1.8% of the experimental group and 35.0 ± 3.5% of controls registered a score of one ($p < 0.05$) (Fig. 2). An excitability score of two was most common and was registered for 25.0 ± 3.5% and 55.0 ± 3.5% of experimental and control animals, respectively ($p < 0.001$). Post-transportation a score of three was most common in experimental goats, and was recorded in 47.5 ± 3.7% of animals immediately after transportation. This value was significantly ($p < 0.001$) higher than the corresponding value recorded in controls (10.0 ± 5.0%). Three hours after the journey, a score of one was recorded for 10.0 ± 0.04% and 5.0 ± 3.5% of the

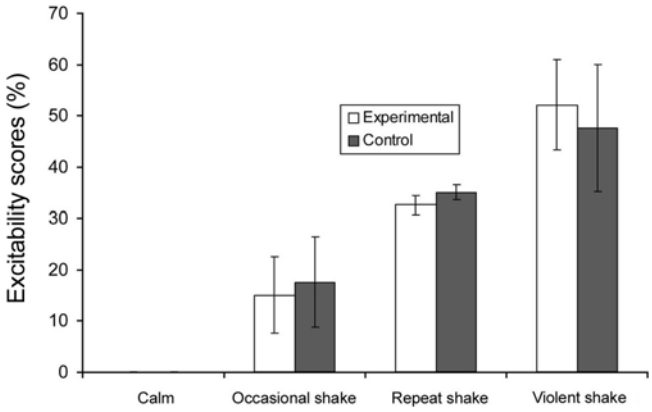

Fig. 1. Excitability scores of experimental (n = 10) and control (n = 7) goats before transportation (%, Mean ± SE).

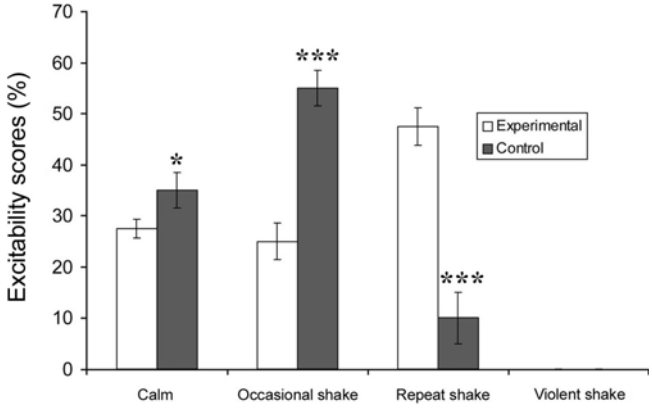

Fig. 2. Effect of road transportation and the administration of ascorbic acid on excitability scores of experimental (n = 10) and control (n = 7) goats immediately after the journey. *$p < 0.05$; ***$p < 0.001$

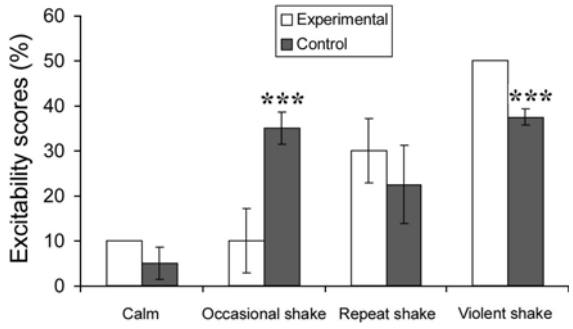

Fig. 3. Three hours post-transportation effect on excitability scores of experimental (n = 10) and control (n = 7) goats. ***$p < 0.001$.

experimental and control goats, respectively. However, the highest percentage of animals with an excitability score of four was obtained for experimental goats at 3 h post-transportation, i.e., 50.0 ± 0.0%. Moreover, this value was significantly higher ($p < 0.001$) than the corresponding value of 37.5 ± 1.8% registered by control goats (Fig. 3).

Excitability scores and percent excitabilities in goats before transportation were positively and strongly ($p < 0.001$) correlated, with values of 0.998 and 0.997 in experimental and control goats respectively. Immediately after the journey, excitability scores and percent excitability values were negatively correlated in both experimental and control goats, with the values of –0.398 and –0.780, respectively. Moreover, the correlation coefficient between excitability scores and percent excitabilities 3 h after transportation was positive and highly significant ($p < 0.001$) in both the experimental and control goats (r = 0.944 and 0.733, respectively).

Discussion

The Red Sokoto goat or Maradi goat is the predominant breed found in the Northern Guinea Savannah Zone of Nigeria. A uniform dark-red color and short horizontal ears and horns (in both sexes) characterize the breed. Males weigh about 27 kg and females 25 kg [8].

The results obtained in the present study describe how the transported goats were subjected to a combination of a high ambient temperature and high RH, which is characteristic of the late hot-dry and early rainy seasons in the Northern Guinea Savannah zone of Nigeria. Moreover, the high ambient temperatures recorded during the study period are higher than the established thermoneutral zone for this animal, which ranges between 12 and 24°C [19]. Similarly, during the journey, DBT and RH values were relatively high, clearly demonstrating that the weather during the hot-dry season is not conducive with the transportation of these animals, even during in the cooler morning period. Furthermore after transportation, ambient temperatures and humidities, both within and outside the pen, were also beyond this established thermoneutral zone. The data obtained demonstrate that goat transportation during the hot-dry season is likely to adversely affect the animals as evidenced by a decrease in excitability scores, and impaired homeostatic control mechanisms.

Meteorological results obtained during the present study agree with previous findings in the Red Sokoto goat that the hot-dry season is thermally stressful to goats [13,2], and therefore, additional stress factors such as transportation, should be reduced to minimum during this season. Similar observations on the negative effect of high ambient temperature and RH on the health and productivity of goats and cattle have been documented [14,25].

The excitability scores recorded in control goats showed that road transportation and high ambient temperatures depressed the animals immediately after the journey. The excitability scores of the animals pre-transportation were substantially higher than post-transportation because of the level of nervous system stimulation triggered by the transportation. These findings are similar to reports on other livestock, where it was found that road transportation, after an initial excitation depresses the nervous system immediately after transportation [1,6,17]. Thus, in the present study, post-transportation the animals appeared fatigued and lethargic.

However, experimental goats treated with AA showed maximal excitability scores immediately after the journey. This result confirms the ability of AA to activate the nervous system in transported goats. Similar findings that AA administration, even at higher doses plays a significant role in the synthesis of neurotransmitters, norepinephrine and 5-hydroxytryptarmine, which are known to be involved in the control of brain function and mood, have been reported [4]. Three hours after transportation, the highest excitability score of four was registered by 50% of the transported goats administered AA, which was not significantly ($p > 0.05$) different from the result recorded pre-transportation. These results show that AA facilitated the rapid transition of the state of depression that followed excitation (occurring during transportation) immediately after the journey, indicating a re-activation of the nervous system. This results support earlier findings [7,16], that AA activates the nervous system, especially the sympathetic nervous system. In goats administered AA, the depression was replaced by excitation shortly after transportation. The results of the present study demonstrate that the administration of AA just before journey start is beneficial in terms of reducing the stressful effect of being transported during hot and humid weather. In addition, they confirm previous findings that AA increases body resistance to environmental stress [12,22,23], by altering the hormones or factors responsible for a shift in the homeostatic mechanism during stressful conditions [18], and by so doing restores the organism's excitability.

The correlation found between the excitability scores and excitability percentages of experimental goats during

transportation strongly suggests that AA reduces the stress caused by such conditions.

The results obtained during the present study show for the first time the beneficial effect that AA has on the excitability scores of Red Sokoto goats transported by road during hot weather. We therefore recommend that AA be administered to goats transported by road during the hot-dry season in the Northern Guinea Savannah zone of Nigeria to reduce the effect of road transportation stress on these animals.

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