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Excitability scores of pigs administered ascorbic acid and transported during the harmattan season

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ABSTRACT

Experiments were performed with the aim of investigating the effect of ascorbic acid (AA) administration on the excitability of pigs transported by road for four hours. Sixteen pigs served as experimental animals and were administered AA orally and individually at a dose of 250 mg/kg dissolved in 20 mL of sterile water, while thirteen pigs were administered only 20 mL each of sterile water *per os* as controls. While the pigs were being weighed, excitability scores were recorded for each pig, before and immediately after road transportation using a standard method. A score of one to four was allocated to each pig, a higher score representing greater excitability. Excitability scores decreased significantly ($P<0.05$) in control pigs immediately after transportation. The results show that road transportation induced considerable stress followed by depression, as evidenced by a lower excitability score recorded post-transportation in control pigs. The administration of AA pre-transportation resulted in the maintenance of excitability of the central nervous system in the experimental pigs following road transportation. In conclusion, AA administration to pigs prior to road transportation during the harmattan season ameliorates the depression induced by the journey, and may enhance their health and productivity.

Key words: ascorbic acid, excitability score, pigs, road transportation

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Introduction

Transportation is an inevitable husbandry practice, which livestock are subjected to as a result of marketing and the need to slaughter them for meat in abattoirs, often located outside the places where the animals are reared (CHANDRA and DAS, 2001; RAJION et al., 2001; RAJESH et al., 2003; PINEIRO et al., 2007). In general, animals perceive any unusual manipulation, including transportation, as stressful, which may ultimately have a negative influence on their welfare (VON BORELL, 2001). Transportation is an unfamiliar and threatening event in the life of an animal. It involves handling, loading, confinement and unloading which are unavoidably stressful and can lead to distress, injury or even the death of the animal (MINKA and AYO, 2007). It often coincides with a change in ownership, whereby responsibility for the animal's welfare may be compromised (TARRANT and GRANDIN, 2000). Road transportation represents a critical phase in animal production and utilization. It is often considered as one of the main causes of stress, adversely affecting production both in economic and animal welfare terms (ELDRIDGE and WINFIELD, 1988; BROOM, 2003). The behavioural changes are often the first sign of distress (AYO et al., 2002), and animal welfare can be assessed based on them. Animal behavioural responses during transportation are diverse and they are dependent predominantly on stimuli received. SAUNDERS and STRAUB (2002) demonstrated that many stressors induced the activation of the autonomic nervous system. SPENCER et al. (1984) reported that the pituitary-adreno-cortical system also plays an important role in the modulation of stress responses. The greatest stress is induced by handling and at the start of a journey, which activates the sympathetic nervous system, including the adrenal medulla and eventually the adrenal cortex (GRANDIN, 1997; FAZIO and FERLAZZO**,** 2003). The behaviour of pigs during transportation has received little or no attention, and this is of concern to animal welfare activists. It has been shown that the behavioural indicators of stress during transportation of pigs include frequent urination and defaecation and attempts to escape, vocalization, struggling and kicking (BROWN et al., 1999; BAUER et al., 2001).

Ascorbic acid (AA) or vitamin C is an effective antioxidant because it plays an important metabolic role in the body. By acting as an electron carrier, it can give up two electrons, and it is converted to dehydro-L-ascorbic acid (WHITEHEAD and KELLER, 2003). It has been established that AA ameliorates the adverse effect of stressful environmental conditions (TAULER et al., 2003; ADENKOLA and AYO, 2006a and b; MINKA and AYO, 2007). Besides, AA can be tolerated without any adverse effect at high doses (BALZ, 2003).

The aims of the present study were to investigate the excitability of pigs transported by road for 4 h during the harmattan season and to determine the modulatory role of AA on the excitability.

Materials and methods

Experimental site. The experiment was performed at the Faculty of Veterinary Medicine, Ahmadu Bello University, Samaru, Zaria (11^0 10' N, 07^0 38' E), located in the Northern Guinea Savannah zone of Nigeria during the harmattan season. The harmattan season in Nigeria occurs between late November and February (OLADELE et al., 2003). This zone is characterized by intensive livestock marketing and, consequently, transportation of pigs, especially at the end of the year. In Nigeria during the season, which coincides with Christmas and New Year celebrations, pigs are usually transported in large number from the north to the middle and the eastern part of the country for the celebrations. Many farmers in the zone practise mixed farming; they sell pigs to generate cash in order to buy items needed for the end-of-the year celebrations.

Experimental animals and management. Twenty-nine local pigs, including males and non-pregnant, non-nursing females of 9 to 12 months old were bought from different localities in Zaria environs at least two weeks before the commencement of the experimental. The live mass of the pigs range between 20-48 kg. They were kept in a communal pen, made of a concrete floor and iron walls with asbestos roofing. The pen measured 7.50 m × 2.55 m with half the length to the roof without block work, which provide adequate ventilation. The pigs were not restrained inside the pen. They were kept under an intensive system of management and fed with maize offal, brewer waste and yam peels. They were given access to water *ad libitum.* The pigs were pre-conditioned for two weeks before the commencement of the experiment. During the period, they were screened for haemoparasites and endoparasites by taking their blood and faecal samples for laboratory analyses. Pigs found to be infected were treated using oxytetracycline deep intramuscularly at the dose of 20 mg/kg and thiabendazole *per os* at the rate of 25 mg/kg body mass of animal (M.S.D AGVET, U.S.A.), respectively.

Meteorological data. During the study period, the meteorological parameters of dry-bulb temperature (DBT) and relative humidity (RH) were recorded at the experimental site using a dry- and wet-bulb thermometer (Brannan, England). The parameters were determined for a total of six days at 06:00, 13:00, and 18:00 h daily, twice a week for three weeks before transportation. Values of the meteorological parameters were also recorded at 30 minutes, 2 and 4 h of the journey.

Experimental design. Rectal temperature (RT) and meteorological parameters were taken at 06:00, 13:00 and 18:00 h twice a week for three weeks before transporting the animals. On the day of transportation the experimental animals (n = 16) were orally and individually administered AA (Juhel Nigeria Ltd., Enugu) at 250 mg/kg (CHERVYAKOV et al., 1977) dissolved in 20 mL of water, while the 13 pigs which served as the control were given 20 mL of sterile water only. AA was administered to the pigs immediately (15 min) before loading them into the vehicle.

Food and water were withdrawn 12 h before commencement of the journey and throughout the journey period. The journey lasted 4 h, including stop-overs to measure meteorological data and time taken for police-checking. The vehicle travelled from the Faculty of Veterinary Medicine, Ahmadu Bello University Zaria on a tarred road along the Zaria-Jos road to Maraban Kubau and back to Zaria covering a total distance of 140 km and at a speed range of 40-50 km/h. After completing the journey, the pigs were unloaded at the original loading point. The animals were fed as earlier, prior to the journey, and were given access to water *ad libitum.*

Vehicle design, loading, and journey time. A standard Ford six-wheeler bus, popularly used in the northern part of Nigeria for transportation of pigs was used to transport the animals. The floor of the vehicle was made of corrugated aluminium sheets, which was covered with dry straw bedding before loading the animals. The inner compartment of the vehicle measured 3.22 × 1.67 × 1.2 m high. The side walls of the vehicle from the floor to the roof were completely covered with corrugated aluminium, and had a window which measured 0.8 × 0.44 m on each side of the vehicle. The windows were positioned at the height of about 1.0 m from the floor. The bus had a door which measured 1.4 × 1.2 m at the rear end. Other transportation procedures were carried out in accordance with standard guidelines governing the welfare of animals during road transportation as described by KNOWLES et al. (1999). Briefly two persons loaded the pigs into the vehicle, under relatively calm conditions. One person caught and carried one pig at a time and led it to the other person, already inside the vehicle who in turn placed the pig inside the vehicle. The pigs were stocked at a density of 0.8 m^2 per animals. They were made to stand inside the vehicle in rows against the direction of movement of the vehicle, facing different directions. The journey commenced at about 8:00 am.

Measurement of excitability scores. Excitability scores were recorded as described by VOISNET et al. (1997), KANNAN et al. (2002) and MARIA et al. (2004) during the weighing of the pigs, before loading into the vehicle and immediately after unloading. The weighing was carried out using a standard scale (Philip Harris, UK). During weighing, the excitability score was done by allocating a score of one to four to each pig by a single observer; a higher score representing a greater level of excitability. A score of one was allocated to a pig 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 the animal struggled violently throughout the entire weighing period.

Statistical analysis. Excitability scores for each period of measurement were summed up and the results are presented as percentiles. Data are expressed as mean ± standard error of the mean (mean ± SEM). Values of $P<0.05$ were considered significant. Student's *t*-test

was used to determine the level of significance between experimental and control animals using the Graph pad prism version 4.00 for Windows (www.graphpadprism.com).

Results

Meteorological data. The ambient temperature recorded during the study period at the experimental site ranged between 19 °C and 23 °C, with a narrow range of 4 °C. The RH during the experimental period fluctuated between 59-85%, and there was no rainfall during the study period. The DBT was highest at 13:00h (Table 1). During the transportation the DBT value inside the vehicle before loading was 18 °C, while the value immediately after loading was 24 °C. Thereafter, the DBT rose gradually from 26.0 °C after the 1st h of the journey, and attained a peak value of 31.0 °C during the 4th h of the journey at 12:00 h (Table 2). The mean DBT inside the vehicle during the journey was 28.3 ± 0.8 °C, whereas the RH ranged between 42-60% with a mean of 51.0 ± 1.5%. Thus, the RH range was 18% during the journey period (Table 2). The meteorological data during the post-transportation period were similar to those obtained during the pre-transportation period (P>0.05).

Table 1. Meteorological data from the study period

Hour	Ambient temperature (°C)			Relative humidity (%)
	Minimum	Maximum	Dry bulb	
06:00	13	24	14	85
13:00	23	24	23	60
18:00	21	22	21	59
Mean ± SEM	19.00 ± 3.05	23.33 ± 0.67	19.33 ± 2.70	68.00 ± 8.50

Table 2. Ambient temperature and relative humidity inside the vehicle during four hours of road transportation.

Hour of journey	Dry bulb (°C)	Relative humidity (%)
30 min	26	42
2	28	51
4	31	60
Overallmean ± SEM	28.33 ± 0.79	51.00 ± 1.5

Excitability score percentage. The results of the excitability scores in both experimental and control pigs pre-transportation are shown in Fig. 1. An excitability score of four was recorded in 53.9 ± 14.4% of the experimental pigs, while a value of 25.0 ± 11.2% was obtained in the control pigs (P>0.05). None of the experimental pigs had an excitability score of two, while a value of 18.8 ± 10.1% was recorded in the control group for the excitability score of two. Immediately after transportation, the highest excitability score of four was recorded in 53.9 ± 14.4% of the experimental pigs (Fig. 2), while the value of 6.25 ± 6.25% was obtained in the control group, and the difference between the value was statistically significant (P<0.05). The excitability score of three was recorded in 12.50 ± 8.54% of the control pigs and this value was lower (P<0.05) than that of 30.8 ± 13.3% obtained in the experimental animals. 7.69 ± 7.7% experimental pigs had the excitability score of 2; but in the control pigs the corresponding value was 43.75 ± 12.8% (P<0.05). The difference in percentages between the experimental and control pigs with a score of one was not statistically significant (P>0.05).

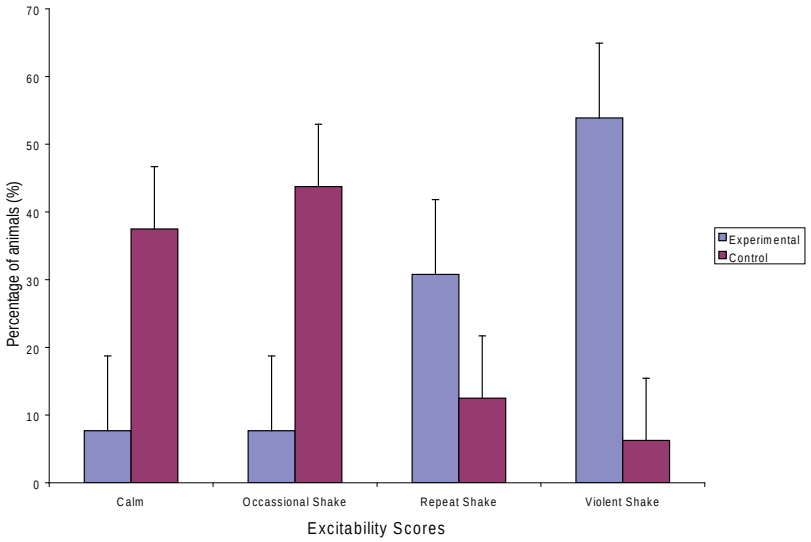

Fig. 1. Excitability scores of experimental (n = 16) and control (n = 13) pigs before 4 h road transportation

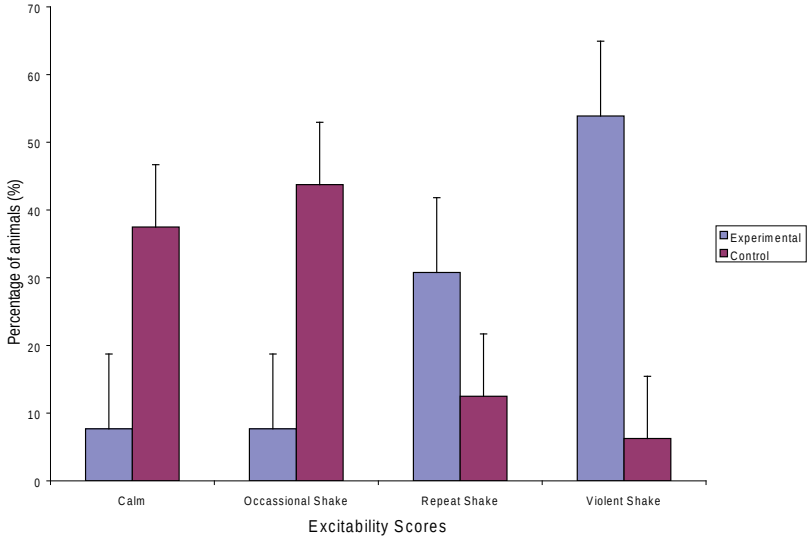

Fig. 2. Excitability scores of experimental (n = 16) and control (n = 13) pigs immediately (within 30 min) after short-term road transportation

Discussion

The results obtained in the present study showed that the transported pigs were subjected to a cold, and dust laden wind with high AT, which are characteristic of the harmattan season in the Northern Guinea Savannah zone of Nigeria. This observation about the season agreed with that made by AYO et al. (1998a and b). Meteorological results obtained during the present study agree with the established findings that the harmattan season is thermally stressful to pigs (ADENKOLA and AYO, 2006b) and goats (IGONO et al., 1982; AYO et al., 1998a and b).

The results obtained for the excitability scores demonstrated that transportation of pigs during the harmattan season, apparently, has adverse effects on the nervous system of the animals, as evidenced by a decrease in the values of excitability scores in the control pigs. The excitability scores recorded in the control pigs suggest that the road transportation and the associated high ambient temperature and RH depressed the excitation of the nervous system of the pigs immediately after the journey. Thus, excitability scores obtained post-transportation in the control pigs was considerably lower than the pre-transportation values. This finding agrees with the reports of other workers in cattle (ATKINSON, 1992; KNOWLES et al., 1999) and goats (AYO et al., 2006) that road transportation depresses the nervous system immediately after transportation. In the experimental pigs treated with AA,

the excitability score was maintained immediately after the journey and was not different from that recorded pre-transportation. The finding shows that AA administration pre-transportation resulted in the maintenance of excitability of the central nervous system in the experimental pigs following road transportation. Thus, AA administration just before the journey was beneficial during the harmattan season. The results confirm previous findings that AA increases body resistance to environmental stress (HASSANZADEH et al., 1997; TAULER et al., 2003; ADENKOLA and AYO 2006a and 2006b). The findings also demonstrated the ability of AA to activate the nervous system in transported pigs, and confirm similar reports that AA administration plays a significant role in the synthesis of neurotransmitters in the brain, involved in the control of brain function and mood (BALZ, 2003). AA thus replaced the depression in transported pigs with excitation immediately after the journey (AYO et al., 2006) as evidenced by higher excitability scores in the transported experimental pigs than those of the control.

The results of the present study demonstrated for the first time the beneficial effect of AA administration on the excitability of pigs transported by road during the harmattan season. It is, therefore, recommended that pigs be administered with AA before transportation by road during the harmattan season in order to reduce the adverse effects of the transportation on their health and thus enhance productivity.

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SAŽETAK

Pokusi su provedeni s ciljem istraživanja učinka askorbinske kiseline na razdražljivost svinja tijekom četverosatnog prijevoza. Pojedinačno je svakoj od 16 pokusnih svinja dana askorbinska kiselina u dozi od 250 mg/kg otopljena u 20 mL sterilne vode, dok je 13 svinja kojima je svakoj dano samo 20 mL sterilne vode per os poslužilo kao kontrola. Stupanj razdražljivosti svinja određivan je za vrijeme vaganja prije i neposredno nakon cestovnoga prijevoza. Svakoj svinji dodijeljeni su bodovi od jedan do četiri s tim da je veći broj označavao veću razdražljivost. Stupanj razdražljivosti bio je značajno manji ($P<0,05$) u kontrolnih svinja neposredno nakon prijevoza. Rezultati su pokazali da cestovni prijevoz potiče značajan stres praćen potištenošću kao što je vidljivo na osnovi manjega stupnja razdražljivosti nakon prijevoza u kontrolnih svinja. Davanje askorbinske kiseline prije prijevoza dovelo je do održavanja podražljivosti središnjega živčanoga sustava u pokusnih svinja nakon cestovnoga prijevoza. Davanje askorbinske kiseline svinjama prije cestovnoga prijevoza u sezoni pustinjskoga vjetra harmattan smanjilo je potištenost uzrokovanu prijevozom, a može poboljšati njihovo zdravlje i proizvodnost.

Ključne riječi: askorbinska kiselina, stupanj razdražljivosti, svinje, cestovni prijevoz