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ORIGINAL RESEARCH ARTICLE

Physiological response of four exotic breeds of boar to humid tropical environment

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ABSTRACT

The study was conducted to assess the thermoregulatory response of four exotic breeds of boar to tropical humid environment. Sixteen (16) exotic boars (four boars per breed) imported from the United Kingdom to Nigeria were used for this experiment. The breeds were Duroc, GC 750 (hybrid), Large white (LW) and Landrace (LR). The ambient temperature and the relative humidity of the pen house were recorded. The thermoregulatory response of the pigs was assessed by measuring the rectal temperature (RT) and respiratory rates 3 times daily: Morning, (8:00 and 8:30 am), afternoon (12:30 and 1:00 pm) and evening (3:30 and 4:00 pm). The daily ambient temperature and relative humidity of the pen house were 27.98±1.66^{0}C and 84.48±5.99% respectively. The daily rectal temperature recorded for LW (37.14±0.45^{o}C) was significantly (P<0.05) lower when compared to other breeds. The daily rectal temperature of GC 750 (37.56±0.62^{0}C) was the highest while the least was recorded in LW (37.14±0.45). The respiratory rate of the boars ranged between 26.16±3.26 (LW) and 27.07±3.96 bpm (GC 750). The physiological response of the boars to tropical humid environment was found to be different among the breeds. The large white showed the best capacity to tolerate heat among the four breeds. It can be concluded that environmental factors such as ambient temperature in humid tropical environment influenced physiological response of exotic boars.

Keywords: Exotic boar breeds, Thermoregulatory response, Tropical environment, Respiratory rate, Rectal temperature

INTRODUCTION

Animals are sometimes exposed to environmental conditions such as climate, nutrition and housing that are different from the one in which they were bred and adapted (Ramutis and Asta, 2011). Animals imported from other countries are subject to different environmental variations and they strive to survive. The ability of pigs to cope in their new environment arises from their capacity to respond to environmental variables and maintain body equilibrium – homeostasis (St-Pierre *et al.,* 2003). However, environmental components such as ambient temperature, relative humidity, wind speed, solar radiation and rainfall have effect on the physiological responses of animals and these responses can be evaluated through rectal temperature and respiratory rate (Hansen, 2004). A rise in rectal temperature (which is an indicator of core body temperature) is a pointer to thermal stress (Lucas *et al.,* 2000). Compared with other livestock species, pigs are more sensitive to high ambient temperatures because they cannot sweat and do not pant so well (Huynh *et al.,* 2005). Heat stress is an occasional challenge during summer in temperate regions (Renaudeau *et al.,* 2010), and a constant problem in many tropical areas. Characterised by high temperature and high relative humidity, heat stress is an important factor contributing to production losses in the swine industry (St-Pierre *et al.,* 2003). Ordinarily, high humidity does not have a negative effect on swine performance. However, combined with high temperatures, high humidity can enhance the negative effects of the high ambient temperatures because pigs rely heavily on evaporative heat loss to stay cool when it is hot (Myer and Bucklin, 2008). At temperatures above the thermoneutral zone, about 24 to 26°C in matured pigs (Myer and Bucklin, 2008), pigs use thermoregulatory mechanisms such as changing posture, vasodilation and increasing respiration rate to increase the transfer of excess heat to the environment. They also tend to minimize metabolic heat production at the upper critical temperature by reducing their feed intake and these usually result into reduced growth rate, poor performance, poor feed

conversion ratio, fertility problems, poor boar fertility, low conception rate, abortion, fewer and smaller litters (Ricald and Lean, 2000; Huynh *et al.*, 2005) and eventually culminate into production loss. Therefore to restore normothermia and homeostasis, pigs under heat stress alter their physiology but with cost to productivity (Huynh *et al.*, 2005). However, it has been reported that genetic differences exist in tolerance to thermal stress within and between temperate and tropical breeds (Soleimani and Zulkifli, 2010; Ogbu *et al.*, 2013). The effects of thermal stress have been noted to be more severe in the exotic breeds reared under tropical climates (Hansen, 2004). It is therefore important to assess and document the differences that may be observed in the adaptive response of exotic breeds of pigs in a humid tropical condition. Thus, this study was conducted to assess the thermoregulatory response of four exotic breeds of boar to humid tropical environment.

MATERIALS AND METHODS

Experimental Site

This study was carried out at the Boar Stud of the Institute of Agricultural Research and Training, (IAR&T), Obafemi Awolowo University, Ikenne Out-Station, Ikenne, Ogun State, Nigeria. The experimental site is in the South Western agro-ecological zone of Nigeria. Ikenne (Lat $6^0$55' N, long.30 35' E) is located within the rain forest belt of Nigeria with annual rainfall between 1200 and 1900 mm. The study was carried out during the early rainy season between May and July 2014.

Experimental Animals and Management

A total of sixteen exotic boars consisting of four breeds which include Large white (LW), Landrace (LR), Gene Converter 750 (GC 750 - a hybrid) and Duroc (DR) with four matured boars per breed were imported from the United Kingdom. The Gene Converter is a Hybrid produced by the JSR Genetics® in the United Kingdom. The animals were randomly housed individually in a pen of 312 × 198 × 114cm dimension in an open sided housing type with concrete wall and floor in a completely randomised design. A pre-experimental period of two weeks was used to get the boars accustomed to the experimental procedure. They were fed daily and water was supplied *ad-libitum.*

The daily body temperature was measured as rectal temperature (RT) by inserting a digital thermometer into the rectum of the boars. The rectal temperature readings were taken three times daily; morning (8:00 am and 8:30 am), afternoon (12:30 pm and 1:00 pm) and evening (3:30 pm and 4:00 pm). The respiratory/breathing rate of the animals expressed as number of breaths per minute (bpm) was measured. This involved counting the flank movements of resting pigs for a minute using a stop watch (Renaudeau *et al.*, 2010). This was done three times daily; in the morning, afternoon and evening. The ambient temperature as well as the relative humidity within the pen was also measured with the use of a digital thermo-hygrometer three times daily.

Data analysis

Data were subjected to analysis of variance using the general linear model of SAS (2003). Means values that were significant were separated using the Duncan's Multiple Range Test (DMRT).

RESULTS

The ambient temperature (AT) and relative humidity (RH) at the different periods of the day (morning, afternoon and evening) in the pen in which the boars were housed are presented in Table 1. The highest AT of 28.58±2.22^{0}C was recorded in the evening while the lowest (26.92±1.49^{0}C) was recorded in the morning. The RH ranged between 80.76±8.75% and 90.14±3.85%. The highest RH was recorded in the morning while lowest RH was recorded in the evening. The rectal temperature (RT) of the different exotic breeds of boar in the tropical humid environment at different period of the day (morning, afternoon and evening) obtained in this study is shown in Table 2. The average RT of Large white at different period of the day was significantly ($P<0.05$) lower than other breeds, however no significant difference was observed among Duroc, GC 750 and Landrace. The least RT was recorded in the morning while the highest RT was recorded in the evening across the breeds. The highest RT of 37.78±0.70 ^{0}C (in the evening) was recorded in GC 750 while the least RT of 36.76 ^{0}C (in the morning) was recorded for Large white. The RT in the pigs increased with change in the period of the day from morning till evening.

Table 1: The average ambient temperature and relative humidity of the experimental environment

Parameter	Morning	Afternoon	Evening	Daily
Ambient temperature (^{0}C)	26.92±1.49	28.43±2.00	28.58±2.22	27.98±1.66
Relative humidity (%)	90.14±3.85	82.82±8.04	80.76±8.75	84.48±5.99

Table 2: Rectal temperature (^{0}C) of exotic breeds of boar in tropical humid environment

Period of the day	Duroc	GC 750	Large white	Landrace
Morning	37.50±0.67^a	37.29±0.65^a	36.76±0.55^b	37.23±0.56^a
Afternoon	37.52±0.56^a	37.60±0.65^a	37.21±0.50^b	37.48±0.49^a
Evening	37.75±0.55^a	37.78±0.70^a	37.45±0.49^b	37.70±0.54^a
Daily	37.54±0.54^a	37.56±0.62^a	37.14±0.45^b	37.47±0.47^a

a,b Means within a row with different superscript are significantly (P<0.05) different
GC 750 - Gene Converter 750

The average respiratory rate (RR) of the boars was not significantly different among the breeds at the different period of the day is shown in Table 3. The RR across the breeds ranges between 25.13±4.37 and 27.80±5.04 bpm. As observed among the breeds, the average RR increased from morning till evening except for GC 750 that had a higher RR in the morning than in the afternoon.

DISCUSSION

The thermoneutral zone of pigs has been described as the range of temperature within which metabolic rate is minimum, constant and independent of temperature (Huynh *et al.,* 2005; Lammers *et al.,* 2007; Martin, 2012). Pigs use thermoregulatory mechanisms such as changing posture, vasodilation and increasing respiration rate to increase the transfer of excess heat to the environment. The average daily ambient temperature (27.98^{0}C) was similar to 27.8^{0}C reported by Ogbu *et al*. (2013) in a study involving pigs in Nigeria. The ambient temperature recorded in the present study during different periods of the day exceeded the optimum temperature range of 21 to 26 ^{0}C recommended for pig pen in hot-humid environments (Myer and Buckling, 2008). This is an indication that the boars were under heat stress. It has been reported that as ambient temperature rises above pigs' thermoneutral zone and approaches their body temperature, they are unable to lose much heat to the environment (Lopez, 2012), thus leading to heat stress which is a constant problem in many tropical areas (Renaudeau *et al.,* 2010). Heat stress is an important factor contributing to production losses in the swine industry (St-Pierre *et al.,* 2003; Renaudeau *et al.,* 2010).

The 80.76% daily relative humidity observed in the present study was an indication of high relative humidity. Although, high humidity itself does not have a negative effect on swine performance, since the pig rely primarily on evaporative heat loss to stay cool when it is hot, the knowledge of humidity level is very important (Myer and Buckling, 2008). The higher the humidity, the less effective the process of evaporative cooling. Myer and Buckling (2008) reported that a temperature above 30°C and 18% increase in relative humidity is equivalent to 1°C rise in air temperature. The average daily ambient temperature and relative humidity recorded in this study indicates that relative humidity could not have aggravated effect of heat stress on the boars. It has been reported that genetic differences exist in tolerance to thermal stress within and between temperate and tropical breeds (Soleimani and Zulkifli, 2010; Ogbu *et al.,* 2013). The least rectal temperature recorded in Large white breed was an indication that among the breeds studied, the Large white had better capacity for heat tolerance. This could be attributed to the fact that the white colour of the breed reflected light and repelled heat which prevent accumulation of heat load, thereby reducing the heat stress which is responsible for increased rectal temperature. The effect of heat stress exerted more on the pigs from afternoon to evening as higher ambient temperatures and rectal temperatures were recorded during these periods of the day.

The higher rectal temperature recorded in the evening across the breeds could be an indication of the effect of increased ambient temperature from afternoon till the evening. Huynh *et al.* (2005) discussed that increased rectal temperature are good indicators of decreased performance of heat-stressed pigs.

Table 3: Respiratory rate (bpm) of exotic breeds of boar in tropical humid environment

Period of the day	Duroc	GC 750	Large white	Landrace
Morning	25.53±3.88	26.79±5.34	25.13±4.37	25.58±3.97
Afternoon	25.69±4.62	26.62±4.54	26.17±3.89	26.37±4.01
Evening	27.54±5.07	27.80±5.04	27.18±4.51	27.44±4.26
Daily	26.25±3.67	27.07±3.64	26.16±3.26	26.46±2.81

GC 750: Gene Converter 750: bpm - breaths per minute

Housing facilities such as cooling/ventilation system could be provided to mitigate the effect of heat stress on production. The range of respiratory rate (25.13 and 27.80bpm) recorded in this study is within the range (12.0 – 32.71bpm) reported by Huynh *et al.* (2005). The fact that there was no significant difference in respiratory rate could be due to the ability of the animal to effectively cool their body without panting.

CONCLUSION

The study showed that the thermoregulatory ability of Large white, Duroc, Gene converter 750 and Landrace varied among one another. The Large white had the better thermoregulatory response to the humid tropical environment.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of the research reported

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