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Influence of temperature humidity index on skin temperature of West African Dwarf goats raised in Nigeria

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ABSTRACT

The influence of temperature humidity index (THI) on skin temperature of West African Dwarf (WAD) goats was evaluated. Based on the recordings of farm ambient temperature and relative humidity, the study was conducted during rainy and dry seasons. Data obtained for temperature and relative humidity were used to develop an index for measuring thermal comfort level for the goats. Thigh, ear and neck temperatures of the animals were measured. One-way analysis of variance (ANOVA) was used to compare variations in the skin temperature of the animals as influenced by ambient temperature and relative humidity. Duncan's Multiple Range test was used to separate the means where significance was indicated. The summary statistics for climatic variations were also calculated within each season. The skin temperature of the goats was significantly ($p<0.001$; $p<0.05$) affected by THI. Exposure of the animals to high ambient temperature and relative humidity resulted in significant increase in skin temperature sites at the neck, ear and thigh of the animals. The goats employ surface areas as a means to dissipate heat load away from their body.

1. Introduction

West African dwarf (WAD) goats are found in large number in the Southern part of Nigeria, They are small, hardy, early maturing, prolific, non-seasonal breeders (Osuagwuh and Akpokodje, 1982) plump, measuring less than 50cm in height , weighs between 20 – 25 kg (Ozoje, 2002) and they are trypanosome-tolerant. Their coat colour varies, ranging from black; brown, to white and combinations of these colours in various proportions. They possess the widest margin of adaptation amongst the ruminants (Oni, 2003).

However, livestock production in tropical and sub-tropical areas of the world are faced with many problems related to hot climate. In such regions, high ambient temperature is the major constraint on animal productivity (Marai et al., 2000). Climatic conditions in these regions are such that the warm hot season is relatively long with intense radiant energy for an extended period of time accompanied with high relative humidity. Exposure to high ambient temperature induces animals to try to balance the excessive heat load by using different means to dissipate, as much as possible, their latent heat. Animals maintain their heat balance through vasomotor control by regulating the amount of blood flowing through the cutaneous vessels by either vasodilation or vasoconstriction (Marai and Habeeb, 1998). Temperature humidity index (THI) is commonly used as an environmental factor to predict production losses of an animal exposed to hot and humid climatic conditions, (Karaman et al., 2007). THI values are not directly measured but calculated by different equations whose independent variables are thermo-hygrometer (Bouraoui et al., 2002; St-Pierre et al., 2003). According to Karaman et al., (2007), THI is a practical computational method developed to make quick assessment of the performance of livestock animals under heat stress using hourly thermo-hygrometer and relative humidity values of indoor air. Thus, this study sought to assess the influence of THI on skin temperature of WAD goats.

2. Materials and methods

The study was conducted at the Teaching and Research Farm of the Federal College of Animal Health and Production Technology, Ibadan Nigeria, between December, 2012 to May, 2013. Temperature and relative humidity in the goat unit were monitored across seasons (rain and dry) and across day periods (minimum temperature in the morning and maximum temperature in the afternoon) two to three days using a DeltaTrak thermo-hygrometer. As far as possible, this instrument was maintained (hung on the wall) inside the pen to provide a record of the temperature and relative humidity experienced by the goats.

Based on the recordings of farm ambient temperature and relative humidity, the study was conducted during rainy and dry seasons to compare parameters in normal and heat stress conditions. Months of December, 2012 to February, 2013 were considered as the dry season, while the months of March, 2013 to May, 2013 were considered as the rainy season periods. Data obtained for temperature and relative humidity were used to develop an index for measuring thermal comfort level for the goats. It was measured according the following equation as developed by Marai et al., (2001): $THI = T - \{(0.31 - 0.31\ RH)\ (T - 14.4)\}$ where T is ambient temperature (0C) and RH is the relative humidity (%). 12 WAD goats of the same age (9 months old) were used for this study. Skin temperature was determined with digital thermometer; each reading was made at a constant depth by compressing in the muscular areas of the ear, neck and thigh on the right side of the animal.

Data collected were statistically analysed using statistical analysis system (SAS, 2004). One-way analysis of variance (ANOVA) was performed to compare variations in the skin temperature (neck, ear and thigh) of the animals as influenced by ambient temperature and relative humidity. Duncan's Multiple Range test was used to separate the means where significance was indicated. The summary statistics for climatic variations were also calculated within each season.

3. Results and discussion

3.1. Average climatic data during dry and rainy seasons

Data summarized in Table 1 shows that the climatic data obtained in wet season differed from the data obtained in the dry season. Values obtained for temperature (32.89 ± 0.570C) and THI (29.50 ± 0.99) in dry season were higher than those recorded in rainy season (24.59 ± 0.44 0C; 25.27 ± 0.15). However, relative humidity was higher in wet season than dry season (54.00 ± 0.99% vs. 47.25 ± 1.54%).

Table 1
Mean temperature, relative humidity and THI during dry and rainy seasons

Variables	Seasons	
	Dry	Rain
Temperature (o C)	32.89 ± 0.57	24.59 ± 0.44
Relative humidity (%)	47.25 ± 1.54	54.00 ± 0.99
THI	29.50 ± 0.99	25.27 ± 0.15

3.2. Effect of thi on thigh temperature of WAD goats

The results of ANOVA of the effects of THI on thigh temperature of WAD goats is presented in Table 2. The thigh temperature of the goats was significantly affected (P<0.05) by THI . The thigh temperature increases with corresponding increase in THI values such that highest thigh temperature (38.95 ± 0.10 0C) was recorded when the THI value was greater than 27.50; closely followed by values obtained when THI ranged between 25.50 -27.50 (38.81 ± 0.07 0C); 38.46 ± 0.090C when THI was 23.50 – 25.50 and the least (38.46 ± 0.090C) was obtained as the lowest THI value (Table 5). The rise in thigh temperature of the goats as a result of their exposure to heat stress as registered by THI is due to the facts that the goats maintain their heat balance through vasomotor control by regulating the amount of blood flowing through the cutaneous vessels by either vasodilation (which stimulates flatten of the hair cover to allow better heat dissipation through conduction, convention and radiation) or vasoconstriction.

Similar result was reported for sheep by Marai et al., (2007) who elucidated that dissipation of excess body heat is performed by evaporation of water from the respiratory tract and skin surface via panting and sweating, respectively. However, when the environmental temperature increases, the legs of sheep dissipate a high proportion of the heat.

Table 2
Univariate analysis of variance of the effects of THI on thigh temperature of WAD goats.

Source of variation	df	Sum of square	Mean square	F-value	Pr>F
TT	3	13.79	4.60	3.62	0.0131*
Error	524	665.51			
Corr. Total	527	679.31			

* - Significant (P<0.05); TT - Thigh temperature (0C)

3.3. Effect of thi on ear temperature of WAD goats

THI significantly affected (P<0.05) ear temperature of WAD goats as presented in Table 3. Highest ear temperature of the goats (36.49±0.200C) was obtained at the highest THI value and the least (35.27 ± 0.170C) when THI was less than 23.50 (Table 5). Exposure of the animals to heat stress challenge as a result of increase in the level of THI resulted in significant increase in ear temperature.

Skin temperature is the result of the adjustment of the skin blood flow that ends with regulation of the heat between the body core and skin (Habeeb et al., 1992). Marai et al., (2007) also reported similar result in sheep that when the environmental temperature increases, the ear of sheep dissipates a high proportion of the heat.

3.4. Effect of thi on neck temperature of WAD goats.

The results of ANOVA of the effects of THI on neck temperature of WAD goats is presented in Table 4.The THI had significant effects (P<0.05) on the neck temperature of WAD goats such that neck temperature increases as the values of THI increase (Table 5). Although the neck temperature did not differ significantly at highest values of THI (> 27.50) and at the range of 25.50-27.50; also there was difference in the neck temperature at THI value of

range 23.50-25.50 and when the THI is less than 23.50. The physiologic mechanisms for coping with heat stress include greater vasodilation with increased blood flow to the skin surface, sweating and a more rapid respiratory rate (Marai and Habeeb, 1998). The increase in neck temperature with corresponding increase in THI of the goats is a means of heat dissipating mechanism exhibited by the animals as this region of the body is part of the body surface area that could enhance heat dissipation from the body through conduction, convention and radiation as reported by Lukefahr, (1998) that anatomical and physiological characters like body surface area, ear length, forage intake capacity and fur density are more closely connected to genetic adaptation to heat stress

Table 3
Univariate Analysis of Variance of the effects of THI on Ear temperature of WAD goats

Source of variation	Df	sum of square	mean square	F-value	Pr>F
ET	3	22.73	7.56	1.85	0.047*
Error	524	2145.65	4.09		
Corr. Total	524	2168.38			

*-Significant (P<0.05), ET- Ear temperature (oC)

Table 4
Univariate analysis of variance of the effects of THI on neck temperature of WAD goats.

Source of variation	Df	Sum of square	Mean square	F-value	Pr>F
N.T	3	13.79	4.60	3.62	0.0131*
Error	524	665.51	1.27		
Corr. Total	527	679.31			

* Significant (P<0.05); NT - Neck Temperature.

Table 5
Effects of the THI on thigh, neck and ear temperatures of WAD goats.

THI				
Parameters	< 23.50	23.50 – 25.50	25.50 – 27.50	> 27.50
Thigh temperature	38.46 ± 0.09c	38.74 ± 0.15b	38.81 ± 0.07a	38.95 ± 0.10a
Neck temperature	38.40 ± 0.15b	38.34 ± 0.11b	38.70 ± 0.07a	38.74 ± 0.10a
Ear temperature	35.27 ± 0.17c	35.81 ± 0.24b	36.40 ± 0.14a	36.49 ± 0.20a

Different superscripts on values represent significant differences among their means (P≤0.05).

The effect of heat increases when heat stress is accompanied with high relative humidity. Exposure of the animals to high ambient temperature and relative humidity (registered by THI) resulted in significant increase in skin temperature sites at the neck, ear and thigh of the animals. Skin temperature is the result of the adjustment of the skin blood flow that ends with regulation of the heat between the body core and skin. Thus, the animals dissipate the heat load from their body through skin temperature sites at the neck, ear and thigh because these parts of the body contribute certain percentage to the surface area of the animals.

References

Bouraoui, R., Lahmar, M., Majdoub, A., Djemali, M., Belyea, R., 2002. The relationship of temperature-humidity index with milk production of dairy cows in a Mediterranean climate. Anim. Res., 51, 470-491.

Habeeb, A.A., Marai, I.F.M., Kamal, T.H., 1992. Heat stress. In: Philips, C., Piggens, D. (Eds.).Farm Anim. Env. C.A.B. Int., pp. 27–47.

Karaman, S., Tarhan, S., Ergunes, G., 2007. Analysis of indoor climatic data to assess the heat stress of laying hens. Int. J.Nat. Eng. Sci., 1 (2), 65-68.

Lukefahr, S.D., 1998. Review of global rabbit genetic resources: special emphasis on breeding programs and practices in the lesser developed countries. Anim. Genet. Res. Inform., 23, 49-67.

Marai, I.F.M., Ayyat, M.S., Abd El-Monem, U.M., 2001. Growth performance and reproductive traits at first parity of New Zealand White female rabbits as affected by heat stress and its alleviation, under Egyptian conditions. Trop. Anim. Health Prod., 33, 457–462.

Marai, I.F.M., Bahgat, L.B., Shalaby, T.H., Abdel-Hafez, M.A., 2000. Fattening performance, some behavioural traits and physiological reactions of male lambs fed concentrates mixture alone with or without natural clay, under hot summer of Egypt. Ann. Arid. Zone., 39 (4), 449–460.

Marai, I.F.M., El-Darawany, A.A., Fadiel, A., Abdel-Hafez, M.A.M., 2007. Physiological traits as affected by heat stress in sheep—A review. Small Rum. Res., 71, 1–12

Marai, I.F.M., Habeeb, A.A.M., 1998. Adaptation of Bos taurus cattle under hot climate conditions. Ann. Arid. Zone., 37 (3), 253–281.

Oni, O.O., 2003. Breeds and Genetic improvement of small ruminants (sheep and goats). A paper presented at the training workshop on small ruminant production, NAPRI, ABU, Shikka. Niger. January., 16-18th, 2003.

Osuagwuh, A.I.A., Akpodje, J.U., 1982. West African Dwarf (FoutaDjallon) goat. 1. Causes of early mortality. Int. J.Goat Sheep Res.,1, 303-309.

Ozoje, M.O., 2002. Incidence and relative effects of qualitative traits in West African Dwarf Goats. Small Rum. Res., 43, 97-100.

SAS., 2004., SAS/STAT. User's Guide (release 8.03). SAS Institute, Cary North Carolina. USA.

St-Pierre, N.R., Cobanov, B., Schnitkey, G. 2003. Economic losses from heat stress by US livestock industries. J. Dairy. Sci., 86, (E. suppl.), E52-E77.