DAILY THERMOREGULATORY RESPONSE OF FOUR BREEDS OF NON-PREGNANT COWS IN IBADAN, NIGERIA

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ABSTRACT

The thermoregulatory responses of 4 non-pregnant cow breeds (Jersey, N'Dama, White Fulani and Sokoto Gudali) totaling 20 with corresponding replicates n = 4, 4, 4, 8 respectively were determined in an experiment. They were housed under similar conditions, fed same diet, fairly evenly aged (2-2½ years) with weights ranging from 270 to 315kg. Pulse rate, heart rate, respiratory rate and rectal temperature of the animals were measured twice daily-before (7:30a.m.) and after grazing (3:00 p.m.). Ambient temperature and relative humidity were also recorded. The pulse rate (beats/minute) in Jersey cows (57.27) was significantly ($P<0.05$) higher than that in N'Dama cows (55.84) which had the least value. Heart rate (beats/minute) was significantly ($P<0.05$) higher in Jersey cows (57.94) than N'Dama cows (56.21). Respiratory rate (beats/minute) in Jersey cows (48.25) was significantly ($P<0.05$) higher than that of N'Dama cows (40.50), White Fulani cows (41.25) and Sokoto Gudali cows (41.88). There was no significant difference in rectal temperature across the breeds. All parameters evaluated were within the normal physiological range for cows. The high respiratory rate in Jersey cows indicated that they reflected heat better than other cow breeds (N'Dama, White Fulani and Sokoto Gudali) examined.

Key words: Thermoregulatory response, pre-gestating cows, humid tropical environment.

INTRODUCTION

Cattle are the most common type of large domesticated ungulates. They are a prominent modern member of the subfamily Bovinae, are the most widespread species of the genus *Bos*, and are most commonly classified collectively as *Bos primigenius* (Grubb, 2005). Cattle are raised as livestock for meat (beef and veal), as dairy animals for milk and other dairy products, and as draft animals (Ajmorne-Marsan *et al.*, 2010). Other products include leather and dung for manure or fuel. In some countries such as India, cattle are sacred and as such are not eaten (Venugopulam, 2003). Life processes of homeotherms (which include cows) are adapted for optimum function in their respective thermal neutral environments. Any change in environmental conditions, as is the case during heat stress which is usually obtainable in the tropics threatens the normal metabolic balance and produces a positive feedback once the temperature is above the upper critical temperature. The tropics include all the areas on the Earth where the sun reaches a sub solar point, a point directly overhead at least once during the year. Nigeria is found in the Tropics, where the climate is seasonally damp and very humid. According to BBC Weather (2010), Ibadan has a tropical wet and dry climate (Koppen climate classification *Aw*), with a lengthy wet season and relatively constant temperatures throughout the course of the year. Ibadan's wet season runs from March through October, though August sees somewhat of a lull in precipitation. This lull nearly divides the wet season into two different wet seasons. November to February forms the city's dry season during which Ibadan experiences the typical West African harmattan. The mean total rainfall for Ibadan is 1420.06 mm, falling in approximately 109 days. There are two peaks for rainfall, June and September. The mean maximum temperature is 26.46 °C, minimum 21.42 °C and the relative humidity is 74.55%. For internal body temperature of homeotherms to remain relatively constant, heat gain must equal heat loss. Cow performance is optimised when environmental conditions do not impact their metabolic rate. This range of environmental/ ambient temperature is called the zone of comfort or thermoneutral zone (St-Pierre *et al.*, 2003). When a combination of environmental factors result in conditions which exceed the thermoneutral zone of a cow, an imbalance in the heat exchange between it and its surrounding environment causes increasing amounts of heat storage (St-Pierre *et al.*, 2003). From that point onwards, thermal or heat stress is experienced. The environmental conditions that induce heat stress can be calculated using the temperature humidity index (THI). There are a number of equations that have been used to calculate THI.

These equations usually include temperature and humidity to calculate THI. Heat stress begins to occur in cattle when the THI is > 72 (McDowell *et al.*, 1972). Direct effects of heat stress on cows include reduced feed intake, increased water intake, metabolic rate alteration, increased maintenance requirement, increased evaporated water loss, increased respiration rate and increased body temperature (Armstrong, 1994). Due to these effects, heat stress has a severe economic impact on dairy and beef industry because of reduced animal performance, reproductive losses and associated increases in mortality (St-Pierre *et al.*, 2003). This experiment was therefore undertaken so as to determine the thermoregulatory response of some cow breeds during the hot dry season in a humid tropical environment.

MATERIALS AND METHODS

Experimental site and management of animals

The study was carried out at the Dairy Unit of the Teaching and Research Farm, University of Ibadan, Ibadan, Nigeria. A total of 20 cows with ages ranging from 2-2½years and weights 270-315kg were used for the 5 month study. They were housed under similar conditions and provided same feed. The animals were grouped into four treatments on breed basis: Jersey (4), N'Dama (4), White Fulani (4) and Sokoto Gudali cows (8). The thermoregulatory parameters were determined twice on a daily basis; 8:00 a.m. (before grazing) and 3:00 p.m. (after grazing) throughout the experimental period (November 2012 to March 2013). Respiratory rate was determined by counting uninterrupted movement of the flank for 60 seconds using a stop watch. Pulse rate was determined by counting uninterrupted rhythmic movement of the jugular vein for 60 seconds using a stop watch. Heart rate was determined with the aid of a stethoscope placed at the heart region with the beats for a period of 60 seconds recorded, while rectal temperature was done by manual insertion of a digital clinical thermometer in each cow's rectum till a constant reading was obtained. Ambient temperature and relative humidity were monitored with the aid of thermo hygrometer.

Data Analysis

All data was subjected to analysis of variance in a completely randomized design using General Linear model of SAS (1999).

RESULTS AND DISCUSSION

All the thermoregulatory parameters of the four cow breeds (Table 1) were significantly ($P<0.05$) different but still within the normal recommended range as documented by Latimer *et al.* (2003). The pulse rate (beats/minute) in Jersey cows was not significantly different from that in White Fulani and Sokoto Gudali cows. It was however, significantly ($P<0.05$) different from N'Dama cows (55.84). Heart rate (beats/minute) in Jersey, White Fulani and Sokoto Gudali cows was not significantly different from one another. However, heart rate in Jersey and Sokoto Gudali cows was significantly ($P<0.05$) higher than in N'Dama cows. The respiratory rate (beats/minute) in N'Dama, White Fulani and Sokoto Gudali cows was not significantly different from one another but was significantly ($P<0.05$) lower than Jersey cows. The daily temperature (°C) ranged from 25-34 while the average mean was 29.3±2.36. The relative humidity ranged from 68-88% with the mean value of 77.7±1.11%. Ghaffar *et al.* (1989) reported that pulse rate is an important physiological parameter that is used in heat stress evaluation and which can be altered by factors such as excitement, exercise and fear. It is therefore not out of place to have variations as was the case with the various cow breeds. Heat stress obviously had a greater impact on Jersey cows at the pre-gestating phase which reflected in their significantly higher pulse, heart and respiratory rates compared to N'Dama cows especially. Accelerated respiratory activity in cattle especially under heat conditions is thought to be related with heat tolerance. Regan and Richardson (1938) indicated that the respiratory system is the principal avenue for heat dissipation in cattle since breathing varied directly with environmental temperature. In comparison between Jersey and Holstein cows respectively, Miller *et al.* (1951) found the respiration rate of Jersey cows to be higher. Physiological factors such as high ambient temperature and nutrition which result in a rise in respiratory rate was perhaps responsible for the rise in the value of respiratory rate of Jersey cows compared to other cow breeds. The high pulse rate of Jersey cows in the afternoon may not be unconnected with the ambient temperature which was also higher at noon. Their confinement to a tropical climate may have precipitated the rise. Richards (1985) explained that an increased heart rate in Jersey cows in the tropics may be due to the

fact that they were not yet fully acclimatized and were exposed to daily acute bouts of heat for the first time which was more pronounced in the daytime. It was a stress response which agrees with the report of Bianca (1959) on the acclimatization of calves to hot, humid environments. Kibler and Brody (1954) showed that Jersey cows had higher respiration rates than Holsteins which was attributed to Jersey cows' better ability to dissipate heat compared to Holsteins. Though indigenous cows like N'dama, White Fulani and Sokoto Gudali were involved in this study, the rise in respiratory rate may probably be attributed to their heat dissipating ability which was perhaps more pronounced in the tropics.

In this study, minimum and maximum ambient temperatures were 25°C and 33°C. The THI was estimated to be 83.2. This result was higher than the reported value of 78 which is said to be the THI for a normal cow. This indicated that the animals were under stress during the period of study.

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Table 1: Average Daily Thermoregulatory Response of different breeds of non-pregnant cow

Parameters	Jersey	N'Dama	White Fulani	Sokoto Gudali
Pulse Rate(Beats/min)	57.27±0.56^{a}	55.84±0.34^{b}	56.66±0.35^{ab}	56.84±0.38^{ab}
Heart Rate(Beats/min)	57.94±0.46^{a}	56.21±0.36^{b}	57.13±0.40^{ab}	57.59±.0.34^{a}
Respiratory Rate(Beats/min)	48.25±1.76^{a}	40.50±0.85^{b}	41.25±1.70^{b}	41.88±0.81^{b}
Rectal Temperature (°C)	38.44±0.19	37.95±0.15	38.00±0.26	38.05±0.31

ab: Means on same row with different superscripts are significantly (P<0.05) different, Beats/ min-Beats per minute, SEM- Standard Error of mean