Correlation between physiological parameters and thermal infrared emissions from free ranging cattle

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Introduction

Thermally stressful environments may cause physiological and metabolic changes in farm animals, among these, a higher methane production by ruminants. In this context, the main thermoregulatory mechanism in homeothermic animals is an increase in surface temperature, although other physiological parameters such as heart and respiratory rates are also indicative of environmental heat stress (Hahn, 1985; Bouzida et al., 2009).

Infrared thermography, a technique that detects thermal radiation emitted by an object, is a non-invasive alternative to evaluate body temperature of free ranging animals.

Goal of this work was to correlate temperatures obtained by thermal imaging with physiological responses from grazing cattle in Central Brazil.

Material and Methods

The trial was carried out at Fazenda São Carlos, Três Lagoas Municipality, Mato Grosso do Sul State, Brazil (20 º 45'04 '' S and 51 º

40'42 '' W), in March and August 2015. Local weather pattern is Aw (tropical hot and humid), according to Köppen classification, with local average temperature and rainfall of 26°C and 1400 mm respectively.

54 young heifers from four different genetic groups were used, i.e, 14 Nellore (NEL), 12 ½ Angus x ½ Nellore (ANGNEL), 14 Senepol (SEN) and 14 ¼ x ¼ Brahman Nellore x 2/4 Senepol (TRI) with average initial live weight of 197, 235, 169 and 233 kg, and final weight of 252, 282, 221 and 276 kg, respectively. Average age was between five and seven months. Animals were kept in Brachiaria brizantha cv. Xaraés pasture, with ad libitum water supply and dry feed supplementation with commercial balanced feed on *creep feeding.*

Physiological parameters evaluated were: rectal temperature (TR °C) using digital clinical thermometer (Digi-temp, Kruuse®), introduced into the animal's rectum with the reading bulb in contact with the mucosa and kept in this position until the read signal was heard. Temperature of skin surface (TSP, °C) and temperature of hair surface (TSPM, °C), read from the animal's back were obtained using a portable infrared pyrometer (model 890, Instrutherm®). Heart beat rate (FC, beats/minute), was obtained by auscultation of the cardiac movements, for 15 seconds, using a stethoscope placed in the 4th intercostal space of animal's right hand side.

Respiratory rate (FR, breaths/minute), was obtained through direct observation of animal1s flank movements for 15 seconds. FC and FR values were multiplied by four to estimate values for a one-minute evaluation.

Thermal emissions were measured through thermographic images from animal's head and the left eye (Figure 1) using infrared imager Testo® (model 875 2i), set to emissivity of 0.95 (animals and biological material) palette for data recording set for hot and cold and 25mm lens (9°x7°). Later, in order to obtain the maximum and minimum values for head (TIC,°C) and eye temperature (TIO, °C), all images were analyzed through IRSoft® (Testo software), with palette for records set

for hot and cold and definition for measuring points set for the options free form and circle. Correlations among the variables were obtained through SAS CORR procedure, version 9.4.

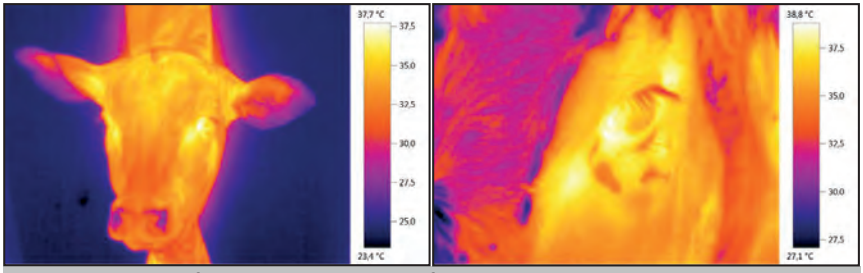

Figure 1: Infrared thermal images of the evaluated spots (head and eye).

Results and Conclusions

The thermoneutral zone in an animal is defined by NÃÃS (1989) as a range limited by the maximum and minimum temperature considered optimal for its husbandry, in which, maintenance of homeothermy occurs with minimal deployment of mechanisms responsible for thermal regulation.

High correlations ($P < 0.05$) were found between infrared eye temperature (TIO) and infrared head temperature (TIC) (0.77), and between temperature of hair surface (TSPM) and temperature of skin surface (TSP) (0.83). Moderate correlation was found between heart beat rate (FC) and respiratory rate (FR) (0.68), and weak correlations were observed between TIO and rectal temperature (TR) (0.41) as well as between TIC and TR (0.45) (Table 1).

In the literature, TR is considered the best indicator for predicting thermoregulation in cattle. Because in this work infrared thermography has shown low/moderate correlation with all other parameters evaluated, it does not hinder its use for inference about thermal regulation processes in cattle, since it is a technology that still needs better-defined protocols for use in free ranging animals.

Table 1. Correlations between thermography and physiological evaluations of different cattle genetic groups

Variable	TIO	TIC	TSPM	TSP	FC	TR	FR
TIO	1	0.77*	0.19	0.09	0.24	0.41*	0.14
TIC		1	0.24	0.23	0.25	0.45*	0.23
TSPM			1	0.83*	-0.17	0.35**	-0.21
TSP				1	-0.22	0.32	-0.17
FC					1	0.18	0.68*
TR						1	0.36**
FR							1

* Significance level with p <0.01; ** Significance level with p <0.05.

TIO: infrared eye temperature; TIC: infrared head temperature; TSPM: temperature of hair surface; TSP: temperature of skin surface; FC: heart beat rate; TR: rectal temperature; FR: respiratory rate

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