Radiant Temperature of Cattle According to Rangeland Environment and Breed

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Introduction

Heat stress can reduce growth rate and reproduction of beef cattle in tropical regions, which might be accentuated under a scenario of climate change. Adaptation of breeds, acclimatisation of individuals, and shade (natural or artificial) can be used to mitigate heat stress in cattle with body temperature used as an indicator (Finch 1977). In the past few years, infrared temperature (IRT) of the eye and hide have been used as an indicators of core body temperature for disease detection and heat produced (Schaefer *et al.* 2012; Montanholi *et al.* 2008). IRT could become an automatic and remote measurement of body temperature to monitor environmental and physiological events related to heat stress. Thus, IRT could assist with management decisions concerning shade, water, disease, and animal selection. However, there is no information comparing body temperature of cattle under different rangeland environments (*e.g.* woodlands vs. savannas).

The objective of this study was to determine body temperature of cattle in relation to breed, age and environmental conditions (ambient temperature and shade) using a non-invasive methodology.

Materials and methods

The study was conducted at the Lansdown Research Station (18º39' S, 146º51' E, 63 m a.s.l.) using 119 steers from 2 breeds being Brahman and Belmont Red Composites (BRC; a tropically adapted interbred *B. taurus* ×*B. indicus*). Seventy-nine of these steers were 2-yr-old that had been on the property for approximately 12 months whereas 40 yearling steers were 1-yr-old weaners brought 1 month prior to the start of the study from Rockhampton (23º13'S; 150º23'E, 15 m a.s.l.). Breed and age groups were randomly assigned to 1 of 2 mobs with balanced numbers. Each mob was allowed to graze one of 2 paddocks, an open woodlands (100 ha with 15 to 30 trees/ha) and an open savannah (50 ha with only 8 scattered trees) in a crossover design of 4 experimental periods from August till November. Body weight, coat score using scale 1 (sleekest) to 5 (thickest), and body temperature using IRT were obtained at the end of each experimental period when animals were brought to the yards and swapped between paddocks. Ambient temperatures during the measurements were 24.1, 31.5, 31.1 and 30.7ºC, and temperature-humidity index (THI) was 69.0, 77.1, 78.3 and 78.0 for periods 1 to 4, respectively. IRT images of each animal were obtained in the crush from the eye and the rump, and from the entire body in the yards after exited the crush (Fig. 1). The maximum temperature of a square enclosing the eye and the average temperature of the rump and trunk were calculated using an emissivity value of 0.98. Data were analysed using a mixed-effects linear regression model considering the fixed effects of breed, paddock, age, and experimental period as repeated measure. Individual within group and group were random effects.

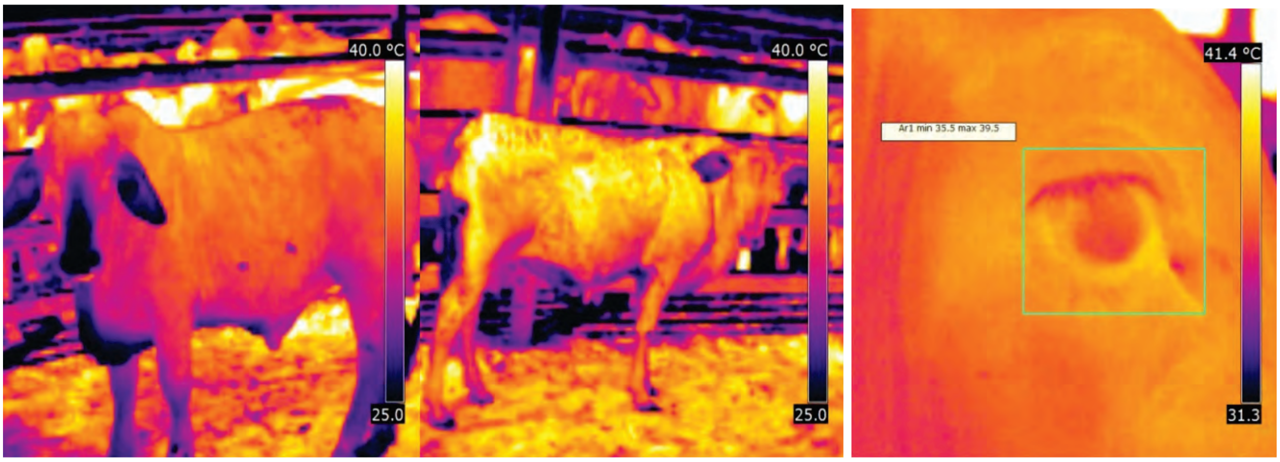

Figure 1. Examples of infrared images from a Brahman and Belmont Composite steer, and the eye.

Table 1. Temperature, coat score and live weight gain (LWG) of Brahman and Belmont Red Composite steers grazing an open-woodland paddock with high proportion of non-grass species or a savannas paddock with low proportion of non-grass species.

Item	Woodland		Savannah		*P*-values		
	Brahman	Composites	Brahman	Composites	Breed	Paddock	B × P
Temperature (ºC)							
Eye	37.8 ± 0.07 y	38.1 ± 0.05 z	38.4 ± 0.06 x	38.4 ± 0.05 x	0.03	<0.001	0.002
Rump	34.7 ± 0.11 y	35.0 ± 0.08 y	35.7 ± 0.11 x	35.5 ± 0.09 x	0.73	<0.001	0.007
Trunk	35.1 ± 0.15 y	35.1 ± 0.12 y	36.4 ± 0.15 x	36.1 ± 0.12 x	0.34	<0.001	0.22
LWG (kg/day)	0.3 ± 0.05 y	0.3 ± 0.04 y	-0.4 ± 0.05 x	-0.1 ± 0.04 z	0.001	<0.001	0.003
Coat score	1.5 ± 0.06 x	2.0 ± 0.05 z	1.4 ± 0.07 x	1.8 ± 0.05 y	<0.001	0.001	0.71

Results and discussion

Body temperature from all body parts increased from September to November with the advance of hotter weather ($P<0.05$; data not shown). A strong positive relationship was found between ambient temperature-humidity index and eye, trunk and rump skin temperatures ($R^2>99.6\%$; data not shown). The elevation in body temperature was higher at ambient THI above 77, which has been considered the threshold above which cattle experience severe heat stress (Mader and Davis 2004). The lower slope of eye temperature compared to skin temperatures indicates that the former is less affected by ambient conditions.

Animals in the woodland had lower temperatures in all 3 body parts and thicker coat than those in the savannah ($P\leq0.001$; Table 1). In addition, Brahman cattle had lower eye temperature than BRC in the wooded paddock ($P<$ 0.05; Table 1) but no differences between breeds were found when grazing in the savannas ($P>0.10$) despite Brahmans had sleeker coat in both paddocks ($P<0.001$; Table 1). The reason for the lack of a difference between breeds in body temperature while grazing in the savannas might be due to the mild weather conditions but research should be done during the wet season when THI are higher.

Younger animals showed greater temperature in all body parts, greater coat score and growth rate compared to older animals ($P<0.05$; data not shown) which may be related to the fact that 1-yr-old animals were not acclimatised to hotter weather in the dry tropics. However, age and acclimatisation might be confounded because growth rate was higher for the 1-yr-old group during the present dry season (data not shown). Comparisons of the aforementioned results with the literature are difficult because there is no previous work performed with IRT that followed the objectives of the present study in beef cattle, and because little is known about thermoregulation mechanisms.

Conclusions

Natural shade from open woodlands might be effective to mitigate heat stress in cattle compared to cleared areas. Adapted breeds and acclimatisation of animals should also be considered as mitigations strategies. Infrared thermography showed to be a good candidate to remotely measure body temperature in cattle to assess several aspects of thermoregulation including adaptation of breeds and individuals to tropical environments, acclimatisation processes to hotter weather, weather events (*e.g.* heat waves) and variation throughout the year, and environmental conditions such as shade. However, more research is needed to understand different aspects of thermoregulation and the relationships with beef production. IRT could help improving our understanding of the relationships between body temperature, heat dissipation or loss, efficiency of energy utilisation, growth rate and reproduction in the tropical rangelands.

References

Finch VA (1986) Body Temperature in beef cattle: its control and relevance to production in the tropics. *Journal of Animal Science* **62**, 531-542.

Mader TL, Davis MS (2004) Effect of management strategies on reducing heat stress of feedlot cattle: Feed and water intake. *Journal of Animal Science* **82**, 3077-3087.

Montanholi YR, Odongo NE, Swanson KC, Schenkel FS, McBride BW, Miller SP (2008) Application of infrared thermography as an indicator of heat and methane production and its use in the study of skin temperature in response to physiological events in dairy cattle (*Bos taurus*). *Journal of Thermal Biology* **33**, 468-475.

Schaefer AL, Cook NJ, Bench C, Chabot JB, Colyn J, Liu T, Okine EK, Stewart M, Webster JR (2012) The non-invasive and automated detection of bovine respiratory disease onset in receiver calves using infrared thermography. *Research in Veterinary Science* **93**, 928-935.